TATA ENERGY RESEARCH INSTITUTE
BANGALORE

COMPREHENSIVE ENERGY AUDIT REPORT

of

BARODA RAYON CORPORATION LTD, FATEHNAGAR, SURAT

POY PLANT

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BARODA RAYON CORPORATION LTD.
FATEHNAGAR, SURAT

POY PLANT

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EXECUTIVE SUMMARY

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1.0 INTRODUCTION

This report presents the findings of Energy Audit of POY plants. Energy Audit study was carried out during Jul-Aug'96 in the following areas to identify energy saving opportunities.

- ⇨ Electrical System
- ⇨ Electrical motors
- ⇨ Refrigeration and Air conditioning - Generation, Distribution and Utilisation
- ⇨ Compressed Air-Generation,distribution and utilisation
- ⇨ Steam System - Distribution and Utilisation
- ⇨ Cooling Towers
- ⇨ Lighting System

During the study every attempt was made to understand the operational features and working of the project in the proper perspectives. For purposes of analysis, the various operations were observed, relevant data collected, measurements taken wherever necessary using portable instruments. There was constant interaction with the plant personnel who gave full support to the study team.

This report presents the analysis, findings and recommendations for achieving energy savings.

2.0 ELECTRICAL SYSTEMS

Reduction of Bus Voltage levels & savings in distribution losses

It is proposed to lower the off load tap setting of transformer No.3 to operate LT bus at 410volts for supply to motive & Lighting loads.

The above recommendation will yield system benefit in addition to savings in distribution losses.

It is also recommended to shift capacitor banks to load end bus to minimise distribution losses. Details are given in Appendix -3/6.

3.0 ELECTRIC DRIVES

A GENERAL

i. Efficient rewinding practices of old motors should be followed.

ii. Plant management should improve the facility of re-winding shop by providing oven for heating the burnt motor and the windings should be removed carefully from slots after cutting the overhang. Burning the motor body at high temperature should be immediately stopped (which is presently being practised for quick results)

iii. Star Mode operation of underloaded motors

The underloaded motors of the plant are recommended to be operated in star mode so that savings in magnetic losses and improvement in operating P.F can be realised. Details are given in Appendix 4/2.

B Replacement of standard efficiency old/rewound motors with new high efficiency motors.

Most of the operating motors are old/rewound several times and the measurement of the instantaneous operating parameters reveal that the operating P F is low. These motors are continuously operating for 4,500 hrs since the plant is on low production now and most of the equipments have standby.

It is recommended to replace such old motors with energy efficient motors. Implementation of above measure is expected to yield energy savings as below.

Annual energy savings	=	4.72 lakh kWh
Cost of energy savings	=	Rs. 20.2 lakh
Total cost of implementation	=	Rs. 22.4 lakhs
Payback period	=	1.1 years

C. Installation of 2 speed motor controller with temperature controllers for 30kW CT fan- 1 or 2.

It is recommended to install 2 speed motor controller and temperature controller for one of the CT fans to automatically operate the drive at lower speed. This low speed operation can be realised whenever the plant is on low production or the ambient temperature is low.

Implementation of the above measure is expected to yield energy savings as below.

Annual energy savings	=	21,900kWh
Cost of energy savings	=	Rs. 93,732/-
Total cost of implementation	=	Rs. 30,000
Payback period	=	0.32 years

D Use of Flat Belts with Flat Pulleys for Drives

There are a number of systems which are coupled to the motors with V belts. Many of these V-belts are loosely driving equipment. It is energy efficient to use nylon synthetic flat belts in place of V-belts especially in systems where annual operating hours are high.

Details of systems recommended for NYLON & NTC plants may be applied similarly to the POY plant.

4.0 COMPRESSED AIR SYSTEM

A. Use of Blower Air for Chip Drying

In the existing system, compressed air is supplied at 7-8 kg/cm^{2}g and used at 800 mmwg. Since the air is used at low pressures, it is felt that blower can be used to generate air at 2000 mmwg and this air can be substituted with compressed air. By implementing this measure, savings are estimated at 4.74 lakh kWh/year. The details are given in section 6.2.G.

Estimated savings

Energy savings	= 4.74 lakh kWh/y
Cost saving	= Rs.20.3 lakhs/y
Investment required	= Rs.15.00 lakhs
Simple payback period	= 0.74 years

B. Use of Separate Low Pressure Compressor for Yarn Interlacing

Yarn interlacing in spinning machine # 5 and 6 requires air at 1.1 kg/cm^{2}g. In the existing system, the air is supplied at 7-8 kg/cm^{2}g and reduced to 1.1 kg/cm^{2}g. Since air is used at low pressure, a separate compressor can be installed for generating air at 2.2 kg/cm^{2}g. This measure can be implemented if the yarn interlacing operates for more than 6000 hours per year.

Estimate• savinqs

Energy savings	= 2.392 lakh kWh/y
Cost saving	= Rs.10.24 lakhs/y
Investment required	= Rs.15.00 lakhs
Simple payback period	= 1.0 years

5.0 STEAM SYSTEM - DISTRIBUTION AND UTILISATION

A. Reduction in heat losses from uninsulated flanges & valves

The flanges and valves of steam lines should be insulated. It is estimated that about 12.42 Mt per annum of coal can be recovered by implementing. (Refer section 7.2.A)

Estimated savings:

Quantity of coal savings	= 12.42 Mt/y
Cost savings	= Rs.0.22 lakh/y
Investment required	= Rs.0.03 lakh
Payback period	= 0.2 year

B. Arresting Steam Leakages

By arresting steam leakages at different locations about 168 tons of steam per year (i.e.,Rs.0.78 lakhs per year) can be saved. (Refer section 7.2.B)

Estimated savings:

Quantity of steam savings	= 168 t/y
Cost savings	= Rs.0.78 lakh/y
Investment required	= Rs.0.20 lakh
Payback period	= 0.25 year

6.0 LIGHTING

A. General

i. The load on three phases are unequal and phase balancing is required to be carried out.

ii. In -take up areas dust proof fittings require regular cleaning & maintenance for better lumen/watt.

iii. Use of electronic choke and 36 watt tube lights should be pursued in future.

B. Energy Efficient Lighting

i. The HPMV lamps of 250W should be replaced with 150W HPSV lamps. This will result in following savings (Ref. Appendix 9/4).

Annual Energy Savings	= 3960 kWh
Annual cost of Savings	= Rs. 16,949/-
Cost of implementation	= Rs. 33,000
Simple payback period	= 1.9 years

ii. Voltage controller must be used at feeder end, to contribute significantly to energy savings (Refer Appendix - 9/5).

Annual Energy Savings	= 29,507 kWh
Annual cost of Savings	= Rs.1,26,290/-
Cost of implementation	= Rs. 2.00 Lakhs
Simple payback period	= 1.58 years

iii. In wet chip blower section and extruder areas 75% of fittings to be controlled through timer and bypass switch. This will result in following savings (Refer. Appendix -9/6).

Annual Energy Savings	= 56,640 kWh
Annual cost of Savings	= Rs. 2,42,419/-
Cost of implementation	= Rs. 60,000
Simple payback period	= 3 months ≈ 0.25 years

iv. In selected areas single tubelight can be removed from Double/Triple fixture as an excellent means for energy savings without investment (Refer Appendix 9/7)

Annual Energy Savings	= 18,720 kWh
Annual cost of Savings	= Rs. 80,122/-
Cost of implementation	= Rs. Nil
Simple payback period	= Immediate

7.0 THERMIC FLUID HEATERS

A. Surface heat losses from Spin Blocks

Insulation of spin blocks with Lloyd wool (IS 3677-1985) of thermal conductivity 0.06 kcal/m.h.^{0}C, two-layer thickness of 75 mm each is expected to yield annual savings to the tune of 0.5 lakh kWh amounting Rs.1.5 lakhs with a marginal investment. Refer section 10.2 A.

Estimated savings:

Power savings	= 0.5 lakhs kWh/y
Cost of savings	= Rs.2.14 lakh/y
Investment required	= Rs.0.03 lakh
Payback period	= Immediate

B. Surface heat losses from Spin Pack Oven doors

Insulation of spin pack oven doors with Llyod wool (IS-3677-1985) of thermal conductivity 0.06 kcal/m.h.^{0}C. Two-layer thickness of 50mm each is expected to yield an annual savings to the tune of Rs.1.3 lakhs with a marginal investment. Refer section. 10.2 B.

Estimated savings:

Power savings	= 0.448 lakhs kWh/y
Cost of savings	= Rs.1.91 lakh/y
Investment required	= Rs.824
Payback period	= Immediate

8.0 SUMMARY OF POTENTIAL SAVINGS

Sl. No	Proposal	Energy Savings				Cost of implementation Rs.	Simple payback period Years
		kWh/Yr	Coal Mt/Yr	Steam Mt/yr	Rs./yr		
1	Electrical Systems	10424	-	-	44615	Marginal	Immediate
2	Electrical Drives	493900	-	-	2113532	22,70,000	1.07
3	Compressed Air System	713200	-	-	3054000	30,00,000	1.0
4	Steam System	0	12.42	168	100000	23,000	0.23
5	Lighitng	108827	-	-	465780	2,93,000	0.64
6	Thermic Fluid Heaters	94900	-	-	405000	3824	Immediate
Total		**1421251**	**12.42**	**168**	**6182927**	**5589824**	**0.90**

MAIN REPORT

BARODA RAYON CORPORATION LTD
FATEHNAGAR, SURAT

COMPREHENSIVE ENERGY AUDIT REPORT

POY PLANT

1.0 INTRODUCTION

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This report presents the analysis, findings and recommendations for achieving energy savings.

2.0 ENERGY CONSUMPTION PROFILE

2.1 ENERGY SOURCES

Electricity and steam are the major sources of energy to the POY Plant. Major portion of electricity is used in motors for driving compressors, pumps, fans and lighting. Steam is coming to utilisation areas from Power Plant. Thermic fluid (S-300) is used as a heating media in extruders.

2.2 PRODUCTION PROFILE

The installed capacity of POY Plant for polyester filament yarn is 10777 Mt per annum. Actual production of POY Plant for the year 1995-96 is given below :

Month	Production, kg
April - 95	628937.58
May	971334.14
June	954800.44
July	891743.06
August	649419.86
September	874115.74
October	947955.14
November	932318.28
December	788803.08
January - 96	643029.07
February	849922.52
March	954834.62
April	880810.41
May	931232.28
June	487581.54
July	510288.32
Total	**12897126.08**

3.0 ELECTRICAL SYSTEMS

This section comprises of study of electrical supply and distribution, loading practices of transformers & PF management and bus voltage co-ordination.

3.1 SYSTEM DESCRIPTION

The plant has maximum operating load of 1700 kW and the electric drives form the main load. 3.3 kV feeders from MRS (66/3.3 kV MRS) supplying four transformers and there is one feeder for R&D transformer.

The details of single line, distribution is given in Appendix - 3/1 and name plate details of transformers are given in Appendix - 3/2.

pf capacitor banks are installed on PCC at the substation and there are no capacitor banks installed at load end bus.

3.2 OBSERVATIONS ANALYSIS AND FINDINGS

Transformer Load Management

The distribution transformers are situated at one location of the plant. The loading of distribution transformers for a typical day was analysed and observation details are given below: (Details are given in Appendix-3/3)

2x1600 kVA transformers

Transformer Ref.	Max. kVA	% Load (Max.)
T1	400	25
T2	Standby	-

The transformer LT bus PF is as high as 0.97.

2 x 2000 kVA transformers

Transformer Ref.	Max. kVA	% Load (Max.)
T3	600	30
T4	600	30

1 x 1000 kVA R&D Transformer

Transformer Ref.	Max. kVA	% Load (Max.)
T1 R&D	100 + 200 *	30

* Additional loads of expansion scheme are proposed.

The transformer LT bus PF measured was observed to be around 0.98.

As such one transformer each is available as standby in both substations and the standby transformer has been kept energised. The loading of three numbers of transformers is less than optimum loading ratio on all transformers.

Switching off one standby transformer of 1600 kVA should be considered to save no load losses. Switching off one standby transformer in cyclic rotation of one month must be considered among 2 x 1600 kVA transformer (only during non-monsoon periods). However this measure should be viewed considering the criticality of power supply to the loads.

3.3 P F MANAGEMENT

The capacitor banks are installed at transformer PCC bus bars through ACB and switchboard mains. The PF capacitor banks are old, however, all the capacitor banks are observed to be in good condition. The distribution of capacitor banks are summarised below: (Details in Appendix -3/4)

Transformer Ref	kVAr connected
T3	300
T4	300
R & D	100

It is observed that the PF of load feeders i.e., CPL extension DB and 09MCC-21 are good, however many loaded feeders are having PF as low as 0.56 and the distribution losses in these feeders are substantial.

From the above, it is observed that the power factor of O/G feeders are good since the PF capacitor banks are arranged optimally on PCC bus. However, it is discussed further that shifting of capacitor banks to load end bus saves energy.

The PF capacitor banks installed on LT PCC should be shifted to load end bus and any additional capacitor banks proposed, must be connected at the MCC end. It is preferable to start motor loads of 37 kW rating and above with capacitors connected directly across motor terminals.

3.4 BUS VOLTAGE LEVELS

The transformer secondary voltage to the plant motive and lighting loads was observed to be in the range of 235-250 volts (410 - 430) Volts.

From the above it is observed that the transformer tap positions are at centre tap (normal position) except for transformer No.-3. The secondary voltages are high and it was observed that lowering secondary voltage to motive and lighting loads is preferable.

At NYLON Plant it was proposed to lower the voltage on secondary with a view to operate the motive loads at lower voltage (overload relay settling off drives should be reviewed and co-ordinated). The additional benefits expected to be derived are :

- ☞ The motors operate cooler
- ☞ To minimise magnetic losses in the prime mover
- ☞ To minimise reactive loading of transformer and incomer

The details of trial conducted at NYLON plant are enumerated below.

Off-Load Tap Changing of Transformer # 3 - 13/2 Substation

Existing tap No: 3

Proposed tap No. 2 (lowered the secondary voltage by 2.5%)

Status/ condition	kW	HT Amps	HT Volts	PF	kVAr	P-N LT volts	Remarks
Before reducing voltage							
Load with capacitor	650.4	117.6	3360	0.95	222	245	A1
Load without 150 kVAr capacitor	644.4 656.4	132.4 128.0	3315 3325	0.86 0.88	381 354	243 243	B1
After reducing voltage (after tap change)							
Load with capacitor a) b)	658.8 626	118.4 109.6	3360 3360	0.97 0.97	168.0 153.6	242 242	A2
Load without 150 kVAr capacitor a) b)	646 613	125.2 122.8	3330 3330	0.89 0.89	339.6 318.0	245 238	B2

Note: Effect of tap change:

A1 - A2 : Reactive power has come down by 54 kVAr

B1 - B2 : Reactive power reduced by 40 kVAr

The plant management has effected the tap change on all distribution transformers and this is being monitored very closely. A total reactive power reduction of 150-200 kVAr has been achieved by the above measure.

It is proposed to lower the tap of transformer No.3 by one step in POY plant to obtain system benefits.

3.5 DISTRIBUTION LOSSES

The LT distribution in the plant is vast covering a large number of LT motors upto 200 HP, whereas, the PF compensation is not provided at load centres. Any efforts to minimise distribution losses in the plant is possible only by installation of capacitor banks at load end bus. Details of HT/LT cable feeders are given in Appendix - 3/5.

It is observed that the overall distribution losses are slightly higher. The medium motors above 37 kW should be connected with appropriate sized capacitor banks (nearest to the load) so that reactive compensation is added in circuit as per requirement of the system. The PF capacitors available at PCC end should be shifted to the MCC load feeder ends to minimise distribution losses. The PF compensation at PCC end could be restricted to about 10% of rating of transformers.

From the data made available, an effort has been made to evaluate annual distribution losses in MCC and motor feeders.

The case study is an illustration to stress the need for shifting capacitor banks nearest to the load and to be switched with the load. Details are given in Appendix - 3/6.

3.6 RECOMMENDATION

A Reduction of Bus Voltage levels & savings in distribution losses

It is proposed to lower the off load tap setting of transformer No.3 by step, to operate LT bus at 410volts for supply to motive & Lighting loads. The above recommendation will yield system benefit in addition to savings in distribution losses. It is also recommended to shift capacitor banks to load end bus to minimise distribution losses. Details are given in Appendix -3/6.

Annual Energy savings = 10424 kWh/
Cost of Energy savings = Rs. 44,615/-
Cost of Implementation = Marginal
Simple payback period = < 1 year.

3.7 SUMMARY OF POTENTIAL SAVINGS

Sl. No	Proposal	Energy Savings		Cost of implementation	Simple payback period
		kWh/year	Rs./Year	Rs. (lakh)	Years
1	Minimising distribution losses	10,424	44,615	Marginal	Less than one year

4.0 ELECTRIC DRIVES

4.1 FACILITY DESCRIPTION

The Plant has large family of motors used for driving pumps, blowers, fans, R&AC plant drives. There are a large nos. of inverters supplying power to motors used for driving machines at different speeds.

These include group drives and many independent drives of rating upto 120 kVA.

A L.T.Motors

The L.T motors of a maximum rating upto 200 kW are installed in plant. About 50 motors above 5.5 kW rating were in operation in the plant for measurement & analysis.

The motors were mainly used for supply / exhaust fans of humidification plants, pumps for process pumping, and other utilities.

4.2 OBSERVATIONS ANALYSIS AND FINDINGS

The details of measurements and observations of the motors are indicated in Appendix 4/1.

The motors of utility section like compressors, chilled water pumps and cooling tower fans are loaded above 80% and other process plant drive equipments are not loaded optimally. the readings were cross checked with the past data sheets of motor loading data since the plant production is presently low. However, it was not varying significantly with the measured readings.

From the above, operating PF of supply and exhaust fans are observed to be low . The detailed measurements of L.T. motors were carried out using hand held power analyser for their operating PF, Amps, kW, Volts. The motors were operating at Voltages of 410 to 430 Volts and generally the loading pattern varies depending on application.

- ⇨ The motors in POY utilities were observed to be loaded above 80%
- ⇨ The take-up and Quench A/W fans are loaded in the range of 30-40%; however the operating P.F is observed to be 0.60 and above.
- ⇨ The chips, and nitrogen blowers are loaded at 40-50%
- ⇨ The vacuum pumps are loaded close to 100%
- ⇨ The booster compressor 1 & 2 are loaded to 63% only
- ⇨ The supply and return air fans are loaded to 46 & 38%
- ⇨ The motors were observed to be rewound several times and many were reported be rewound for more than 2-3 times. General observations like poor operating PF and motor operating hot are the results of to rewinding the motor several times (resulting in higher losses in motors). The rewinding practice of motors in the plant also needs a review since efficient rewinding practice always results in improvement of operating efficiency. Guideline for efficient motor rewinding practice will be given in separate report.

4.3 STAR MODE OPERATION OF UNDERLOADED MOTORS

The motors operating below 40% are proposed to be operated in star mode. Few motors loaded less than 40% were taken up and the power parameters were measured again to ensure that motor loading does not exceed this range. As reported by plant, the loading pattern has been the same even during higher production periods.

The plant management should take up the task of changing the motor connections from delta to star mode for the following motors

Sl.No	Motor/ Application	Rated kW	Measured kW	% Load
1	Take up return air fan-1 *	75	21.9	29.2
2	Take up supply air fan-1	75	29.434	39.1
3	Roots blower B-601	15	4.5	30
4	Roots blower B-603	30	8.1	27
5	Wet Chip Transfer Blower-1	45	18.42	40.9
6	AHU spin drawn 604B	5.5	1.7	31.11
7	Take up supply air fan-2	75	35.1	46.6
8	Take up return air fan-2	75	28.2	37.6

* Already operating in star mode

The implementation of the above measure is expected to yield marginal energy savings in addition to demand reduction and reduction in distribution losses in feeders.

4.4 REPLACEMENT OF STANDARD EFFICIENCY, OLD-REWOUND MOTORS WITH NEW HIGH EFFICIENCY MOTORS

The plant has number of motors operating continuously (over 5000 operating hours per annum) in the range of 5.5 kW to 110 kW; These motors were observed to be standard efficiency motors, and rewound several times.

Even a slight increase in operating efficiency of standard motors will yield in energy savings which is the most obvious design feature of an EEM (Energy Efficient motor). EEM's not only save energy in themselves and contribute to reduced demand, but also contribute towards saving energy in cables and transformer that feed the motor. Most EEM's have a higher PF of operation than standard efficiency have EEM's motor. EEM's are likely to run cooler since they have 20-40% lower losses. EEM's are a better option in some duty cycling for withstanding higher ON/OFF cycle.

The motors operating for more than 4,500 hours are recommended for replacement with high efficiency motor. Appendix 4/3 uses an empirical method, for evaluating the techno economics of installing a high efficiency motor in place of standard efficiency motor.

The above measure should be programmed in phases and spare motors should also be procurement with EEM's only;

Implementation of the above measure is expected to yield annual energy savings of 4.72 lakh kWh, with an investment of Rs.22.39 lakhs;. Refer Appendix 4/3 for details.

4.5 INSTALLATION OF 2 SPEED MOTOR CONTROLLER WITH TEMPERATURE CONTROLLER FOR 30 kW CT FAN MOTOR 1 OR 2

The CT fan 1 & 2 are installed with 2 speed motors and operations at low speed is carried out during winter period. The manual changeover of motor terminal connections may be made automatic by using a 2 speed motor starter. Energy conservation by installing a temperature controller to operate the motor at lower speeds is possible since this avoids manual errors and delays.

The above proposal of installing a 2 speed motor control and temperature control is expected to yield additional energy savings for 1000 hrs in a year by changing over to low speed operation during low ambient/low production periods. Details are worked out in Appendix 4/4.

4.6 INVERTER LOADING PARAMETERS & REDUCING V/F RATING OF DRIVES

The inverters are used for extruders, friction/goddet rollers metering pumps etc., The details of power measured on inverters of various drives are given in Appendix 4/5.

A. Tryout of measuring the power parameters of inverters feeding grove rollers, friction rollers and goddet rollers was carried out by changing the v/f ratio of each inverter. Details are given in Appendix -4/6. The 3φ power analyser with printer was used for measurements. From the readings tabulated for the three inverters and Appendix, results are analysed as below.

i. Grove Roller drive

The grove rollers are operating with vobulation and hence the power drawn is not steady varying from 0.3kW to 6.5 kW. The PF of operation and load current drawn was also varying much. However, with a change in V/F from 1.8 to 1.7, marginal reduction in power consumption could be noticed.

ii. Friction Roller Drive

The power consumption with V/F ratio changed from 2.5 to 2.38 was showing about 0.2 to 0.5 kW reduction in power consumption. This was observed when the machine was operating without yarn.

iii. Goddet Roller Drive

The power consumption with V/F ratio of drive changed from 2.6 to 2.46 showed a variation in power consumption of 0.70 to 0.80 kW.

From the above analysis it is mentioned that energy savings and reduced motor heating (due to reduction in magnetic losses) can be achieved by optimally selecting the V/F ratio of each drive.

Quantification as such has not been carried out and plant management may tryout the above for each V/F inverter drives.

4.7 USE OF FLAT BELTS WITH FLAT PULLEYS FOR DRIVES

There are a number of systems which are coupled to the motors with V belts. Many of these V-belts are loosely driving the equipment. It is energy efficient to use nylon synthetic flat belts in place of V-belts especially in systems where annual operating hours are high. (Air washer and other fan drives).

It is observed from manufactured data that 5% energy savings are possible for drive rating of 37kW & above and about 3-4% savings for drives less than 37kW.

4.8 RECOMMENDATIONS

A GENERAL

i. Efficient rewinding practices of old motors should be followed.

ii. Plant management should improve the facility of re-winding shop by providing oven for heating the burnt motor and the windings should be removed carefully from slots after cutting the overhang. Burning the motor body at high temperature should be immediately stopped (which is presently being practised for quick results)

iii. Star Mode operation of underloaded motors

The underloaded motors of the plant are recommended to be operated in star mode so that savings in magnetic losses and improvement in operating P.F can be realised. Details are given in Appendix 4/2.

B Replacement of standard efficiency old/rewound motors with new high efficiency motors.

Most of the operating motors are old/rewound several times and the measurement of the instantaneous operating parameters reveal that the operating P F is low. These motors are continuously operating for 4,500 hrs since the plant is on low production now and most of the equipments have standby.

It is recommended to replace such old motors with energy efficient motors. Implementation of above measure is expected to yield energy savings as below.

Annual energy savings	=	4.72 Lakh kWh
Cost of energy savings	=	Rs. 20.20 lakh
Total cost of implementation	=	Rs. 22.4 lakhs
Payback period	=	1.1 years

C. Installation of 2 speed motor controller with temperature controllers for 30kW CT fan- 1 or 2.

It is recommended to install 2 speed motor controller and temperature controller for one of the CT fans to automatically operate the drive at lower speed. This low speed operation can be realised whenever the plant is on low production or the ambient temperature is low.

Implementation of the above measure is expected to yield energy savings as below.

Annual energy savings	=	21,900kWh
Cost of energy savings	=	Rs. 93,732/-
Total cost of implementation	=	Rs. 30,000
Payback period	=	0.32 years

D Use of Flat Belts with Flat Pulleys for Drives

There are a number of systems which are coupled to the motors with V belts. Many of these V-belts are loosely driving equipment. It is energy efficient to use nylon synthetic flat belts in place of V-belts especially in systems where annual operating hours are high.

Details of systems recommended for NYLON & NTC plants may be applied similarly to the POY plant.

4.11 SUMMARY OF POTENTIAL SAVINGS

Sl. No	Proposal	Energy Savings		Cost of implementation Rs. (lakh)	Simple payback period Years
		kWh/year	Rs./Year		
1	Replacement of standard efficiency motors with high efficiency motor	4,72,000	20,20,160	22,40,000	1.1
2	Installation of 2 speed motor controller with temperature controller	21,900	93,372	30,000	0.32
	Total	4,93,900	2113532	22,70,000	1.07

5.0 REFRIGERATION AND AIR CONDITIONING

5.1 FACILITY DESCRIPTION

The refrigeration generation system is centralised consisting of 3 centrifugal machines, 2 of 600 TR and one of 585 TR. The various design parameters of refrigeration machines, chilled water pumps and condenser pumps are given in Appendix 5/1.

5.2 OBSERVATIONS, ANALYSIS AND FINDINGS

A. Loading pattern of Compressors Pumps and Fans.

The loading pattern of motors connected to compressors pumps etc., have been discussed separately in Chapter-4.

B Machine side parameters of various refrigeration units.

The observation on machine side parameters of various refrigeration units are tabulated in Appendix-5/2. The performance parameters are observed to be normal.

C Performance Evaluation

The determination of actual load of refrigeration generated needs measurement of chilled water flow and temperature drop across chiller. The actual TR generation is 324 TR which is 54% of the rated value. The estimated specific power consumption is 1.00 kW/TR. The lower load is due to part load of the plant and various energy conservation measures implemented. Calculation details are given in Appendix -5/3.

D Evaporator and Condenser Effectiveness

The observed temperature and pressure drops across evaporator and condenser are given below. They are found to be satisfactory.

Chilled Water		Condenser Water	
Temp drop °C	Pressure drop kg/cm_2	Temp rise °C	Pressure drop kg/cm_2
3.4	0.55	2.5	0.5
4	0.55	2.2	0.5
4.5	0.55	2.7	0.5
3.0	0.55	2.8	0.5

E Distribution System

The distribution network of the refrigeration system has been observed to be satisfactory.

F User Load Assessment

Assessment of chilled water loads has been carried out for all the major user areas. User wise measured loads have been given below. Calculation details are given in Appendices - 5/4 to 5/8.

User Area	Measured Load TR	Design Load TR	% Load
Take up air washer	110	134	82
Quench Air washer	109.4	440	25
Danier Testing Room	23.3	19.0	121
Inverter Room	29.5	47	63
Textile Lab	5.0	11.5	43
Total	277.2	651.5	42.5

The lower overall TR load is due to reduced TR load in quench air-washer. This is in view of modifications carried out.

6.0 COMPRESSED AIR SYSTEM

6.1 FACILITY DESCRIPTION

POY plant is installed with seven reciprocating, double stage, non-lubricating compressors. During normal operation, two/three compressors will be in operation. The compressor specifications are given in Appendix - 6/1.

The compressed air is used mainly in chip dryer, yarn suction guns, yarn interlacing, etc.

R&D plant is provided with one compressor for high pressure air requirement.

6.2 OBSERVATIONS, ANALYSIS AND FINDINGS

A. Free Air Delivery (FAD) Test of Compressors

Free air delivery of all compressors were estimated by measuring suction air velocity across the filter. By and large, all compressors were delivering to their rated capacity except IR # A compressor. The detailed calculations are given in Appendix - 6/2.

Compressor	Design FAD m^3/h	Actual FAD m^3/h	% FAD delivered
KGK # A	1035	929.35	89.79
KGK # B	1035	936.96	90.53
KGK # C	1035	1003.62	96.97
KGK # D	1035	1005.05	97.11
KGK # E	1035	1019.30	98.48
IR # A	1395	1140.25	81.74
IR # B	1395	1248.62	89.51
R&D Compressor	342	292.80	85.61

It can be observed that IR # A compressor is delivering at 81.74% which is on lower side. The low FAD is due to increase in clearance volume of this compressor by large size of gasket (3mm gasket instead of 1.5mm gasket).

B. Loading Pattern of Compressor Motor

Loading pattern of compressor motor during loading and unloading were studied by measuring various parameters such as kW, pressure, etc.

Compressor	Application	Make	Rated kW	Actual kW	% loading	Air Pr, kg/cm^2g
KGK # A	Process air	KGK	110			7.5
Loading				101.4	92.18	
Unloading				14.61	13.28	
KGK # B	Process	KGK	110			7.5
Loading				99	90.00	
Unloading				14.34	13.04	
KGK # C	Process	KGK	110			7.5
Loading				100.2	91.09	
Unloading				18.6	16.91	
KGK # D	Process	KGK	110			7.5
Loading				94.2	85.64	
Unloading				15.69	14.26	
KGK # E	Process	KGK	110			7.5
Loading				97.5	88.64	
Unloading				16.8	15.27	

Compressor	Application	Make	Rated kW	Actual kW	% loading	Air Pr, kg/cm^2g
IR # A	Process	IR	200			7.5
Loading				152.4	76.20	
Unloading				26.28	13.14	
IR # B	Process	IR	200			7.5
Loading				138	69.00	
Unloading				21.36	10.68	
R & D Compr.	Process	KPL	45			9.5
Loading				38.7	86.00	
Unloading				6.3	14.00	

It can be seen that during loading of compressor, all the motors were loaded optimally.

C. Specific Energy Consumption

Specific energy consumption of all the compressors were estimated. SEC depends upon the capacity of compressors, type, delivery pressure, etc.

Compressor	Application	Make	Actual FAD, m^3/h	Actual kW	$kW/(100m^3/h)$	Air Pr, kg/cm^2g
KGK # A	Process	KGK	929.35	101.4	10.91	7.5
KGK # B	Process	KGK	936.96	99	10.57	7.5
KGK # C	Process	KGK	1003.62	100.2	9.98	7.5
KGK # D	Process	KGK	1005.05	94.2	9.42	7.5
KGK # E	Process	KGK	1019.3	97.5	9.57	7.5
IR # A	Process	IR	1140.25	152.4	13.37	7.5
IR # B	Process	IR	1248.6	138	11.05	7.5
R&D Compr.	Process	KPL	292.80	38.7	13.21	9.5

It can be observed that all the compressors in the POY plant having specific energy consumption in the range of 9.57-11.98 $kW/(100\ m^3/h)$ except in IR # A compressor which is 13.37 $kW/(100\ m^3/h)$. The high specific energy consumption is due to low free air delivery of the compressor, while in the case of R&D compressor, the SEC is 13.21 $kW/(100\ m^3/h)$, which is on higher side due to high delivery pressure (9.5 kg/cm^2g).

D. Efficiency of Compressor

Efficiency of compressor system includes motor efficiency, compressor efficiency and transmission efficiency. Efficiency of all compressors in POY and R&D plants was estimated by monitoring the actual FAD, delivery pressure and power consumption. The following table gives efficiencies of the compressors:

Compressor	Efficiency, %
KGK # A	62.48
KGK # B	64.52
KGK # C	68.28
KGK # D	71.32
KGK # E	69.88
IR # A	51.01
IR # B	62.22
R&D Compr.	57.58

It can be noticed that all the compressors are operating at optimum efficiencies, while compressor IR # A is operating at low efficiency which is due to its low free air delivery of the compressor. The details of efficiency calculations are given in Appendix - 6/3.

E. Compressor Operating Parameters

All compressors were studied for various operating parameters such as delivering pressures, loading and unloading pressures, water temperature and air temperature of intercoolers, stage pressures and stage temperatures, etc. All these parameters are tabulated in Appendix - 6/4.

F. Compressed Air Utilisation

Major compressed air users are chip dryers, grinders, yarn interlacing, Danier testing, yarn suction guns. The pressure and quantity of air required in these areas are given in the following table:

Areas/equipment	Supply Pr, kg/cm^2g	Actual Pr, kg/cm^2g	Max. Req, m^3/h	Remarks
Chip drying[1]	-	0.08	400-1200	3 nos of chip drying machine.
Winder control	7.8	6.8	250	$1 m^3/h$ per winder,16 winder in SNIA m/c,
				96 winder for 1-4 machines,32 winder for 5-6 m/c
Yarn interlacing	1:1	1	900	
Danier testing	7.8	7.8	50	50m3/h per table,8 testing tables, 6h/day per table
Yarn suction gun	7.8	7-7.5	300	72 mins/4--6hr per m/c,4 m/c out of 7 m/cs in operation

[1]Chip drying m/c : During study 1 out of 3 m/c is in operation. Each m/c consumes 400 m^3/h.

[2]Yarn interlacing : Yarn interlacing is used in POY m/c 5 & 6. During the study, they were not in operation.

[3]Danier testing table: 5 tables out of 8 in operation

Compressors in operation = 2 Nos. (KGK # C and KGK # D)

Ratio of loading and unloading = 70:30

It can be seen that dryers require compressed air at pressure of 0.08 kg/cm^2g, while interlacing requires pressure of 1 kg/cm^2g.

G. Use of Blower Air for Drying Chips in NARA and ROSIN machines

Compressed air to the chip dryers is supplied at 7-8 kg/cm^{2}g. This high pressure air is reduced to 800 mmwg through a PRV and used for drying chips. since the air is used at very low pressure (i.e., 800 mmwg) it is felt that blower air generated at 2000 mmwg can be substituted, considering pressure drop of 1200 mmwg in the air while passing through the air dryer.

The present system has heat of compressor dryers, in which heat in compressed air is used for regeneration of desiccant. In the proposed system, the external heaters are required to heat the desiccant, since the blower air temperature will be much lower than regeneration temperature.

During the evaluation of feasibility, the power consumed by blowers, blower for desiccant regeneration, heater (dryer power) was considered. The following tables gives the comparative analysis of existing and proposed system:

Particulars	Units	Present system	Proposed system
Requirement of air			
- Rosin dryer-1	m^3/h	400	400
- Rosin dryer-2	m^3/h	400	400
- NARA dryer	m^3/h	400	400
- Total	m^3/h	1200	1200
Supply pressure	kg/cm^{2}g	7-8	2000 mmwg
Sp.power consumption	kW/(100 m^3/h)	10	2.59
Total power consumption	kW	120	31.05
Dryers in operation	-	2	2
Power consumption for two dryers	kW	-	20.7
Savings in power for two dryers	kW	-	59.3
Energy savings	L.kWh/y	-	4.74
Cost savings	Rs.lakh/y	-	14.23

It can be observed that by replacing compressed air with blower air, annual energy savings to the tune of 4.74 lakh kWh (i.e., Rs.20.3 lakhs) can be envisaged due to differential in power consumption. The complete details are given in Appendix - 6/5.

H. Use of Low Pressure Air Compressor for Yarn Interlacing

In spinning machines No.5 and 6 of POY plant, compressed air of 900 m^3/h is used at 1.1 kg/cm^2g to strengthen the yarn by nodding. The air is supplied at 7-8 kg/cm^2g and reduced to 1.1 kg/cm^2g. Since the air is used at low pressure, a separate low pressure air compressor can be installed to generate air at 2.2 kg/cm^2g. By implementing the measure, the savings are estimated at 2.39 lakh kWh/y. While carrying out the techo-economics power consumption for driers and additional investment required for dryer were considered.

The following gives the comparative analysis of existing and proposed system:

Particulars	Units	Present system	Proposed system
Compressed air requirement	m^3/h	900	900
Supply pressure	kg/cm^2g	7-8	2.2
Power consumption	kW	90	50.12
Power savings	kW	-	39.88
Energy savings @ 6000 h/y	L.kWh/y	-	2.392
Cost savings	Rs.lakh/y	-	10.24

The details of the measure is given in Appendix - 6/6. In order to arrive at feasibility, the interlacing of spinning machines should be in operation for more than 6000 hours/year. Hence this measure can be considered if the machines operate continuously.

I. Proposed System of Compressed Air

After considering the various measures suggested, the proposed system of compressed air was worked out. The proposed system of compressed air system is :

Present System:

No of compressors in operation	= 7
Compressor FAD in operation	= 3
(Considering 100 % loading)	= 51.75 m^3/min
	= 3105 m^3/h

Proposed system :

System	Pressure, kg/cm^{2}g	Air required, m^3/h
Use of Blower air for drying chips	200 cmwg	1200
Use of separate compressor for yarn interlacing	2.2	950
Use of existing one compressor for high pr. requirement	7-8	955
Total		**3105**

6.4 RECOMMENDATIONS

A. Use of Blower Air for Chip Drying

In the existing system, compressed air is supplied at 7-8kg/cm^{2}g and used at 800 mmwg. Since the air is used at low pressures, it is felt that blower can be used to generate air at 2000 mmwg and this air can be substituted with compressed air. By implementing this measure, savings are estimated at 4.74lakh kWh/year. The details are given in section 6.2.G.

stimated savings

Energy savings	= 4.74 lakh kWh/y
Cost saving	= Rs.20.3 lakhs/y
Investment required	= Rs.15.00 lakhs
Simple payback period	= 0.73 years

B. Use of Separate Low Pressure Compressor for Yarn Interlacing

Yarn interlacing in spinning machine # 5 and 6 requires air at 1.1 kg/cm^2g. In the existing system, the air is supplied at 7-8 kg/cm^2g and reduced to 1.1 kg/cm^2g. Since air is used at low pressure, a separate compressor can be installed for generating air at 2.2 kg/cm^2g. This measure can be implemented if the yarn interlacing operates for more than 6000 hours per year.

Estimated savings

Energy savings	= 2.392 lakh kWh/y
Cost saving	= Rs.10.24 lakhs/y
Investment required	= Rs.15.00 lakhs
Simple payback period	= 1.46 years

6.5 SUMMARY OF POTENTIAL SAVINGS

Sl. No.	Proposal	Savings Potential		Cost of implementation (Rs.lakh)	Simple payback period) (Years
		L.kWh/y	Rs. lakh/y		
1.	Using blower air for chip drying	4.74	20.3	15.00	0.73
2.	Using separate low pressure compressor for yarn interlacing	2.392	10.24	15.00	1.46
Total		**7.132**	**30.54**	**30.00**	**1.0**

7.0 STEAM SYSTEM - DISTRIBUTION AND UTILISATION

7.1 FACILITY DESCRIPTION

To remove the moisture content from the POY chips two Rosin dryers and one Nara dryer are installed in the plant. For these dryers steam is the base heating, where as electric heaters for controlling the temperature. Steam utilisation areas are given in Appendix - 7/1. To the plant from power plant 15 kg/cm^2 HP line and 3.5 kg/cm^2 LP line are coming to utilisation area.

7.2 OBSERVATIONS, ANALYSIS AND FINDINGS

A. Insulation Survey

A detailed survey was carried on various distribution lines and equipments. All steam lines were adequately insulated and the status of insulation was found to be satisfactory. The observed surface temperature are given in Appendix - 7/2.

Some uninsulated pipe lines and flanges are found, the total heat loss from these lines are nearly 11119.02 kcal/h. The cost of surface heat losses after the insulation is estimated as 1286.07 kcal/h. By insulating these uninsulated pipes and flanges, the savings is estimated at 12.42 Mt of coal, with an investment of Rs.0.03 lakh.. Details are given in Appendix - 7/3.

B. Steam Leakages

Steam leakages from the gland and condensate pipe line has been observed. Sources of leakages and estimated quantity have been tabulated in Appendix- 7/4. Quantified steam leakages work out to approximately 168 ton per year. Plugging steam leakages is at an estimated investment of Rs.0.20 lakh.

C. Steam Traps

It is observed that steam traps are not working. Steam is venting out through the steam traps. Location of the steam traps which are not working are given in the Appendix - 7/5.

7.3 RECOMMENDATIONS

A. Reduction in heat losses from uninsulated flanges & valves

The flanges and valves of steam lines should be insulated. It is estimated that about 12.42 Mt per annum of coal can be recovered by implementing. (Refer section 7.2.A)

Estimated savings:

Quantity of coal savings	= 12.42 Mt/y
Cost savings	= Rs.0.22 lakh/y
Investment required	= Rs.0.03 lakh
Payback period	= 0.2 year

B. Arresting Steam Leakages

By arresting steam leakages at different locations about 168 tons of steam per year (i.e.,Rs.0.78 lakhs per year) can be saved. (Refer section 7.2.B)

Estimated savings:

Quantity of steam savings	= 168 t/y
Cost savings	= Rs.0.78 lakh/y
Investment required	= Rs.0.20 lakh
Payback period	= 0.25 year

7.4 SUMMARY OF POTENTIAL SAVINGS

Sl No	Measure	Savings		Cost savings Rs. lakh/y	Investment reqd. Rs. lakh	Simple payback, years
		Coal Mt/y	Steam Mt/y			
1	Arresting steam leakages	-	168	0.78	0.20	0.25
2	Insulating uninsulated pipes, valves & flanges	12.42	-	0.22	0.03	0.2
Total		**12.42**	**168**	**1.00**	**0.23**	**0.23**

8.0 COOLING TOWERS

8.1 FACILITY DESCRIPTION

The Cooling tower caters to cooling of refrigeration condenser water, compressor inter and after cooler water.

8.2 OBSERVATIONS, ANALYSIS AND FINDINGS

A Performance Evaluation

The performance evaluation of cooling tower is carried out. The parameters monitored were inlet outlet temperatures fresh air dry wet bulb temperatures. The tabulated values are given in Appendix -8/1. The range (difference in temperature of inlet and outlet cooling water temperatures) and the approach (difference in temperature of wet bulb and outlet water temperature) are tabulate below:

Time	Range (°C)	Approach (°C)
9.50	2.0	2
11.30	2.5	2
15.30	3.5	2
Average	2.7	2

It is observed that actual heat load is about 50% of the design load.

9.0 LIGHTING

9.1 FACILITY DESCRIPTION

The study of lighting in POY plant and R&D Centre are covered in this section. The plant can broadly be divided into the following areas.

a R/A Room /Sales, Godown/Workshop area etc.,
b Inverter Room
c SNIA Machine
d ROSIN/NARA Dryer Area.
e Spinning Area.
f Extruder Area

The total connected Lighting load is 85 kW in POY plant and 11 kW in R&D establishment.

The details of Lighting installations are presented in Appendix 9/1.

9.2 OBSERVATIONS, ANALYSIS & FINDINGS.

A General

i. The plant is not currently operating at its rated production capacity.
ii. The house keeping measures in maintaining lighting fixtures adopted by the plant is quite upto the mark.
iii. In corridor and office/godown area, Natural light ingress is very low, making it mandatory to switch on the lights during daytime.

iv. In packing area more use of natural light during day time can reduce lighting consumption.

v. Mostly for all lighting circuit separate switching is done.

vi. In Nara Dryer & Silo area auto switching with timer control is adopted. However, the plant has bypassed timer & switched 'off' as a measure towards cost saving.

vii. In wet chip blower area (in NYLON building) HPMV Lamps are kept switched on throughout the night, though normally no work is carried out.

viii. Similarly, in extruder area lights are left on inspite of having separate switches at entrance.

ix. There are a few triple fixture for tube lights and presently there is no voltage controller being used for lighting circuit.

B. Illumination Level

i. IS 3546 Part I suggests the following illumination lux levels for fertiliser, petroleum, chemical and petrochemical works.

1 Exterior walkways, platforms, stairs and ladders:- 30-50-100 lumen
2 Exterior pumps and valve areas:- 50-100-150 lumen
3 Pump and compressor house:- 100-150-200 lumen
4 Process plant with remote control:- 30-50-100 lumen
5 Process plant requiring occasional manual intervention:- 50-100-150 lumen
6 Permanently occupied work-stations in process plants:- 150-200-300
7 Control rooms for process plant:- 200-300-500

ii. The lux levels measured in various locations are presented in Appendix -9/2. Generally the level of illumination is satisfactory.

C. Lighting Load

The Lighting load at main feeder point is measured and found to be 31.46 kW with power factor 0.86-0.94. The neutral current is high at 30.8 Amps, which should be looked into for phase balancing.

In R&D section, the load is recorded to be 4.93 kW with P F of 0.80-0.94.

D. Energy Efficient Lighting

i. The plant using 11X 250W HPMV lamps in Sales godown area. These can be replaced with 150W HPSV lamps, which will give savings of 100W per lamp and the benefit of increased illumination. The detail calculation are given in Appendix-9/4.

ii. Use of voltage controller will help in reducing consumption by 10-15% with better life and slight (5-7%) lumen reduction. The details are enumerated in Appendix 9/5.

iii. Switching off through timer and by pass circuit in the area of extruder & wet chip blower section shall result in substantial savings. Details are given in Appendix - 9/6.

iv. Removal of single tubelight from double /triple fixture in non-working areas can be an excellent measure for energy saving. A Case Study is presented in Appendix -9/7. The plant can identify such location for adoption without any investment.

9.3 RECOMMENDATIONS:

A. General

i. The load on three phases are unequal and phase balancing is required to be carried out.

ii. In -take up areas dust proof fittings require regular cleaning & maintenance for better lumen/watt.

iii. Use of electronic choke and 36 watt tube lights should be pursued in future.

B. Energy Efficient Lighting

I. The HPMV lamps of 250W should be replaced with 150 W HPSV lamps. This will result in following savings (Ref. Appendix 9/4).

Annual Energy Savings	= 3960 kWh
Annual cost of Savings	= Rs. 16,949.00
Cost of implementation	= Rs. 33,000
Simple payback period	= 1.9 years

ii. Voltage controller must be used at feeder end, 'to contribute significantly to energy savings (Refer Appendix - 9/5).

Annual Energy Savings	= 29,507 kWh
Annual cost of Savings	= Rs.1,26,290/-
Cost of implementation	= Rs. 2.00 Lakhs
Simple payback period	= 1.58 years

iii. In wet chip blower section and extruder areas 75% of fittings to be controlled through timer and bypass switch. This will result in following savings (Refer. Appendix -9/6).

Annual Energy Savings	= 56,640 kWh
Annual cost of Savings	= Rs. 2,42,419/-
Cost of implementation	= Rs. 60,000/-
Simple payback period	= 3 months ≈ 0.25 years

iv. In selected areas single tubelight can be removed from Double/Triple fixture as an excellent means for energy savings without investment (Refer Appendix 9/7)

Annual Energy Savings	= 18,720 kWh
Annual cost of Savings	= Rs. 80,122/-
Cost of implementation	= Rs. Nil
Simple payback period	= Immediate

9.4 SUMMARY OF POTENTIAL SAVINGS

Sl. No	Proposal	Annual Savings		Cost of implementation Rs.	Simple payback period Years
		kWh/year	Rs. /year		
1	Replacement of HPMV 250W by 150 W HPSV	3960	16,949	33,000	1.9
2	Voltage controller used at feeder end.	29,507	1,26,290	2,00,000	1.58
3	Wet chip blower section and extruder areas 75% of fittings to be controlled through timer and bypass	56,640	2.42,419	60,000	0.25
4	Removal of Single Tube Light from Double/Triple fixtures	18,720	80,122/-	Nil	Immediate
	Total	**1,08,827**	**4,65,780**	**2,93,000**	**0.64**

10.0 THERMIC FLUID HEATERS

10.1 FACILITY DESCRIPTION

The spinning section of the plant have six individual extruders and along with SNIA machine separate extrudes are installed. SNIA machine is not in operation. All extruders are with in-built electric heaters. Each extruder has separate spin block arrangement with electric heaters. The specifications of electric heaters are given in Appendix- 10/1. These electric heaters will maintain dowtherm set temperature at 290° C. To preheat the spin packs, three spin pack ovens with electric heating are installed.

10.2 OBSERVATIONS, ANALYSIS AND FINDINGS

A. Spin Blocks

With in-built electric heaters, dowtherm temperature inside the spin blocks is maintained. It is observed that in operation set temperature is 290°C. When spin blocks are not in operation set temperature is 260 °C . Surface temperatures of spin blocks are found to be high.

Surface temperatures of spin block No.5 & 6 are given below.

Sl No.	Particulars	Area, m^2	Surface temp, ^0C	Set temp, ^0C
1	Spin block 5	12.28	110	289
2	Spin block 6	9.78	72	260

Due to this high surface temperature losses are calculated and given in the Appendix - 10/2. By replacement of suitable insulation, losses can be reduced. By taking different rectangle block dimensions suitable insulation needs to be provided. Details of dimensions are given in Appendix -10/3. The savings after replacement of insulation are given in the Appendix - 10/4.

The summary of the savings are given below:

Particulars	Before insulation heat loss, kcal/h	After insulation heat loss, kcal/h	Savings in heat loss, kcal/h	kW
Spin block 5	11658.9	1209.2	10449.7	12.15
Spin block 6	4006.4	963.07	3043.3	3.5

B. Spin Pack Ovens

It is observed that inside spin pack oven temperature is 340 °C. Spin Pack oven surface temperature are given below. The details of surface heat losses are given in Appendix - 10/5.

It is found that oven door temperatures are around 130-140 °C. From door dimensions, suitable insulation calculated is given in Appendix - 10/6. Calculated heat losses from the doors are given in the Appendix -10/7. By providing suitable insulation losses can be reduced. The summary of the savings are given below:

Oven No.	Surface heat losses before insulation kcal/h	Surface heat losses after insulation kcal/h	Saving in heat kcal/h	Power savings kW
No.1	3369.8	389.11	2980	3.46
No.2	2748.9	389.11	2359	2.74
No.3	3092.6	389.11	2703	3.14

10.3 RECOMMENDATIONS

A. Surface heat losses from Spin Blocks

Insulation of spin blocks with Lloyd wool (IS 3677-1985) of thermal conductivity 0.06 kcal/m.h.^{0}C, two-layer thickness of 75 mm each is expected to yield annual savings to the tune of 0.5 lakh kWh amounting Rs.2.14 lakhs with a marginal investment. Refer section 10.2 A.

Estimated savings:

Power savings	= 0.5 lakhs kWh/y
Cost of savings	= Rs.2.14 lakh/y
Investment required	= Rs.0.03 lakh
Payback period	= Immediate

B. Surface heat losses from Spin Pack Oven doors

Insulation of spin pack oven doors with Lloyd wool (IS-3677-1985) of thermal conductivity 0.06 kcal/m.h.^{0}C. Two-layer thickness of 50mm each is expected to yield an annual savings to the tune of Rs.1.88 lakhs with a marginal investment. Refer section- 10.2 B.

Estimated savings:

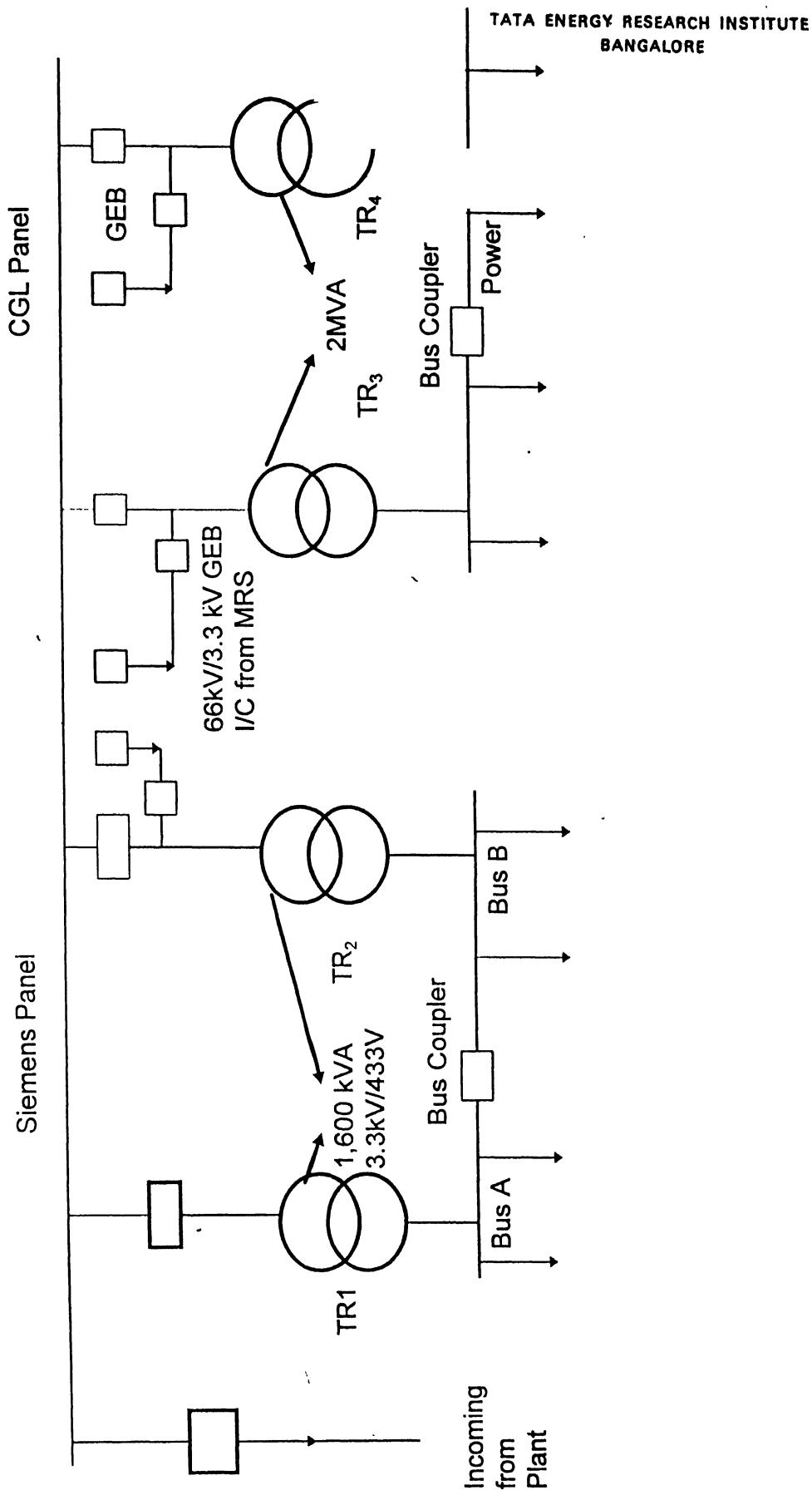
Power savings	= 0.448 lakhs kWh/y
Cost of savings	= Rs.1.91akh/y
Investment required	= Rs.824
Payback period	= Immediate

10.4 SUMMARY OF POTENTIAL SAVINGS

Sl No	Measure	Annual savings		Investment reqd.	Simple payback, period
		Power L.kWh	Rs.lakh	Rs.lakh	years
1	Insulating to spin block # 5 & 6	0.5	2.14	0.03	Immediate
2	Insulation to spin pack oven doors	0.44	1.91	0.008	Immediate
Total		**0.94**	**4.05**	**0.038**	**Immediate**

APPENDICES

SINGLE LINE DIAGRAM OF ELECTRICAL DISTRIBUTION

TATA ENERGY RESEARCH INSTITUTE
BANGALORE

NAME PLATE DETAILS OF TRANSFORMER AND TEST CERTIFICATE

		1	2	3	4	5
1	TR.ID.No	TR#1 (Sr. No. 2484/0)	TR#2 (Sr. No. 2484/2)	TR#3(Sr. No. v7583/1)	TR#4 (v7583/1)	TR(R&D) (83/187/2493/1)
2	Type	Core type, ONAN	Core type, ONAN	Core type, ONAN	Core type, ONAN	Core type, ONAN
3	Appl./Location	POY S/S	POY S/S	POY S/S	POY S/S	R&D S/S
4	Rating in kVA	1600	1600	2000	2000	1000
5	Voltage HV/LV/in kV	3.3/0.433	3.3/0.433	3.3/0/433	3.3/0.433	3.3/0.433
6	Voltage	230/2134	280/2134	349.9/2666.74	349.91/2666.74	175/1334
7	% Impedence in ohm (per phase)	6.02%	6.08%	6.10%	6.12%	6.48%
8	Vector Group	DYN 11	DYN11	DYN11	DYN11	DYN11
9	O.L.T.C	No	No	No	No	NO
10	Tap setting	-7.5% to +5% instead of 2.5% (Primary side)	-7.5% to +5% instead of 2.5% (Primary side)	-7.5% to +5% instead of 2.5% (Primary side)	-7.5% to +5% instead of 2.5% (Primary side)	-7.5% to +5% instead of 2.5% (Primary side)
11	No Load loss in kW	2.3625	2.250	2.045	2.035	-
12	Full Load loss in kW	17.543	17.044	20.622	20.621	-
13	Average load Amps	-	-	-	-	-
14	Peak Load Amps	150A	-	100A	210	35
15	Average Load P.F	-	-	-	-	-
16	Peak Load P.F	-	-	0.92	0.94	-
17	Weight of core and winding kgs.	2125	2125	2760	2780	1475
18	Name of Manufacturer	Bharat Bijlee Ltd, B'bay	Bharat Bijilee Ltd, B'bay	Crompton Greaves Ltd	Crompton Greaves Ltd	Bharat Bijilee Ltd, B'bay
19	Year of Manufacturing	Dec'83	Dec' 83	1990	1990	1983
20	Any rewinding or major repairs	No	No	No	No	No
	Remarks	Operates on BRC supply System	This X'mer is st. by. Normally charged on BRC Supply System. Alternative Supply from 66 kV S/S(GEB)	This X'mer is st. by. Normally operates on BRC Supply System. Alternative Supply from 66 kV S/S(GEB)	Normally operates on GEB Supply System. Alternative Supply from BRC source	Operates on GEB supply

TATA ENERGY RESEARCH INSTITUTE
BANGALORE

TRANSFORMER LOAD MANAGEMENT

Time	TR #1 (1.6 MVA)			TR #3 (2MVA)			TR #4 (2MVA)			TR#R&D (1MVA)		
	Volt	Amps	kVA load	Volt	Amps	kVA load	Volt	Amps	kVA load	Volt	Amps	kVA load
10. 00 A.M	415	450	323	440	640	488	400	720	499	430	100	74
12.00 P.M	421	500	365	440	680	518	412	800	571	430	100	74
14.00 P.M	415	400	288	440	64	49	408	800	565	425	120	88
16.00 P.M	412	500	357	440	640	488	406	720	506	430	100	74
18.00 P.M	412	300	214	440	640	488	400	560	388	425	100	74
20.00 P.M	415	450	323	440	68	52	400	720	499	430	-	0
22.00 P.M	415	400	288	440	640	488	410	560	398	430	-	0
24.00 P.M	415	300	216	440	640	488	410	560	398	425	-	0
2.00 A.M	415	300	216	440	640	488	410	400	284	430	-	0
4.00 A.M	415	300	216	440	640	488	410	560	398	430	-	0
6.00 A.M	415	200	144	440	640	488	410	560	398	430	-	0
8.00 A.M	413	450	322	440	640	488	405	480	337	430	-	0

APPENDIX - 3/4

CAPACITOR BANK DETAILS (POY AND R&D PLANTS)

Sl. No	Location	TR/Motor/Load ID Code No.	System Voltage	Total kVAr	Remarks
1	PCC (LT Side)	TR #3 (2MVA)	415 V	300	Both Capacitors are kept off
2	PCC (LT Side)	TR#4 (2MVA)	415 V	300	Both Capacitors are kept on
3	PCC (LT Side)	R & D TR	415 V	100	Capacitor in service

APPENDIX - 3/5

H.T CABLE DETAILS (POY/R&D PLANTS)

Sl. No	Name of Circuit		Cable size mm^2	Running length in mtrs	No. of runs	Max. Load in Amps
	From	To				
1	Power Plant S/G room	Incoming Panel POY S/S SP#1	400	1200	3	240
2	POY S/S	TR#1(1.6MVA)	240	30	2	150
3	POY S/S	TR#2 (1.6MVA)	240	40	2	
4	POY S/S	TR#3 (2MVA)	400	60	2	100
5	POY S/S	TR#4 (2MVA).	400	35	2	210
6	66kV S/S	Isolator of TR#2	400	217	2	
7	Isolator TR#2	Transformer (1.6MVA)	400	45	2	
8	66kV S/S	Isolator of TR#3	400	219	2	100
9	66kV S/S	Isolator of TR#4	400	221	2	210
10	66kV S/S	Isolator of CC#1	240	350	1	75
11	66kV S/S	Isolator M2	240	350	1	75
12	66kV S/S	Isolator of M3	240	350	1	80
13	R&D S/S	Isolator of TR (R&D)	400	120	1	35

APPENDIX - 3/6.

L.T. CABLE SIZE/LENGTH DETAILS (POY PLANT)

Sl. No	Feeder No.	Cable Size mm^2	Running Length in mtrs.	No. of Runns	Max. Load in Amps
1	1F3	400	170	2	150
2	2F2	400	130	3	250
3	5F2	400	120	3	340
4	5F2	185	270	1	120
5	2F3	400	170	1	165
6	3F2	185	35	1	83
7	2F1	400	100	3	360
8	12F1	400	80	3	180
9	12F2	400	80	3	180
10	11F1	400	85	3	180
11	A11F2	400	85	3	225
12	1OF1	400	170	1	150
13	9F2	6	20	1	5
14	9F1	400	180	2	-
15	9F3	400	15	1	225
16	1OF2	400	15	1	225
17	18F2	400	150	3	375
18	17F1	400	150	3	375
19	18F1	400	95	3	360
20	16F1	185	280	1	120
21	17F2	400	80	2	85
22	15F3	185	10	1	225
23	16F3	185	10	1	225
24	2OF3	400	130	2	80
25	16F2	400	150	3	600
26	15F1	400	150	3	440
27	15F2	400	180	2	160
28	2OF1	6	20	1	5
29	2OF2	185	10	1	83
30	-	95	100	1	150

Appendix - 3/6 contd.

Computation of Savings in Distribution Losses in MCC Feeders

Sl. No	Feeder Details	Present PF	Reqd. PF	Max. Demand kVA	Capacity Reqd. kVAr	% Reduction in Current	Saving in Dist. losses kWh	Demand Savings kVA	Annual Savings Rs.
1	1F3	0.93	0.95	107.5	7	7	85.9	2.3	368
2	2F3	0.78	0.95	128	47	18	1626.1	22.9	6960
3	12F2	0.7	0.95	179	86	26	425.8	47.1	1822
4	16F2	0.84	0.95	476	127	12	4234	55.1	18121
5	15F1	0.82	0.95	360	109	14	2660.8	49.3	11388
6	15F2	0.82	0.95	172	98	34	1391.6	57.9	5956
							10424.2	234.6	44615

APPENDIX - 4

MOTOR LOADING PARAEMTERS

Sl No	MOTOR ID CODE/APPLICATION	RTD kW	MEASURED POWER PARAMETERS $V/_L$	I	PF	kVA	kW	% loading
	PLANT : POY							
1	COOLING TOWER FAN-2	30.00	412	44	0.87	30.12	25.20	84.00
2	C.T.FAN - 1	30.00	407	45.00	0.88	33.30	28.50	95 00
3	CHILLED WATER P.NO.2	67.50	410	87.50	0.84	62.70	31.50	46.67
4	COMPRESSOR NO.4	110.00	412	70.90	0.44	50.49	87.90	79.91
5	C.T.PUMP NO.3	55.00	410	68.00	0.89	105.30	45.30	82.36
6	QUENCH A/W SUPPLY FAN-2	110.00	417	130.00	1.00	93.00	73.80	67.09
7	TAKE-UP CIRCLE PUMP NO.1	26.00	410	34.20	0.78	24.33	18.69	71.88
8	TAKE UP PJN. AIR FAN-1	75.00	410	34.37	0.81	25.80	21.90	29.20
9	LAB A.W FAN-1	3.70	410	7.00	0.72	5.22	4.20	113 51
10	TAKE UP SUPPLY AIR FAN-1	75.00	412	64.00	0.60	46.50	29.43	39.24
11	QUENCH CIRC. PUMP-2	18.50	415	19.7	0.68	13.92	10 89	58.86
12	D.T.ROOM -2 A.H.U-B	7.50	412	9.50	0.66	6.78	4.50	60 00
13	INV.ROOM -2 A/W	15.00	410	18.20	0.64	12.90	9.60	64.00
14	AIR DRYER PLANT-3	21.00	409	27.70	1.00	20.40	19 50	92 86
15	I.R.COMPR K-453-B	200.00	410	210.00	0.88	147.60	132 00	66 00
16	EXTG. BLOWER	2.20	410	2.70	1.00	2.01	1 68	76.36
	CIRCLE BLOWER	37.00	409	40.00	0.92	28.20	27.36	73.95
	PADDLE DRYER	30.00	409	26.32	0.57	20.70	13.80	46 00
17	CHIPS BLOWER	45.00	410	40.00	0.68	29.58	22.20	49.33
18	N_2 BLOWER B-601	11.00	402	12.60	0.51	8.40	4.50	40.91
19	ROOTS BLOWER B-601	15	402	11.8	0.64	8.19	4.50	30.00
20	ROOTS BLOWER B-603	30	402	22	0.53	16.80	8.10	27.00
21	RECYCLE AIR FAN-ROSING DRYER NO.2 K-1110	37	407	52.7	0.91	37.11	32.43	87.65
22	COMPRESSOR NO.3	110	416	158.2	0.85	106.80	90.00	81.82

Sl No	MOTOR ID CODE/APPLICATION	RTD kW	MEASURED POWER PARAMETERS					% loading
			$V/_L$	I	PF	kVA	kW	
23	C.T.PUMP P 203-A	15	397	16	0.71	13.17	11.22	74.80
24	CHILLER WATER PUMP NO.3	67	409	98	0.86	68.10	58.20	86.87
25	WET CHIP TSFR BLOWER nO.1	45	400	41.9	0.6	28.50	18.42	40.93
26	WET CHIP TSFR BLOWER No.2	45	400	51.5	0.71	35.43	26.16	58.13
27	BOOSTER COMP. - 1	37.5	400	35.1	0.9	24.90	23.25	62.00
28	BOOSTER COMP - 2	37.5	400	40	0.86	27.69	23.82	63.52
29	REFRIG UNIT CHILLER 601	55	428	48.4	0.54	40.50	24.60	44.73
30	AHU SPIN DRAW 604 B	5.5	431	6	0.38	4.35	1.71	31.09
31	AHU QUENCH 605-A	1.5	433	2.1	-	1.59	-	
32	PRIMARY CHILLER PRIME PUMP	5.5	431	6.9	0.8	5.07	5.10	92.73
33	SEC. CHILLER PRIME PUMP 603	5.5	431	6.7	0.82	5.07	5.16	93.82
34	AIR COMPRESSOR 607	45	428	66.7	0.86	49.50	38.70	86.00
35	HOT WIP -615	1.5	424	4.1	0.46	4.80	2.10	140.00
36	A.H.U.-3 PHY LAB 606	2.2	424	3.7	-	2.73	1.44	65.45
37	D.M.W.P.611	1.5	424	2.5	-	1.89	2.16	144.00
38	COND. W.P - 608	11	424	13.9	0.68	10.38	8.70	79.09
	R & D							
39	VAC PUMP	4	426	4	0.8	5.07	4.08	102.00
40	VAC. PUMP - B	2.2	424	2.6	-	2.07	2.28	103.64
41	QUENCH MONO EXH. FAN	1.1	421	1.5	-	1.41	1.44	130.91
42	SPIN DRAW , EXH. FAN	5.5	421	5.8	0.67	4.20	3.27	59.45
43	EXTRUDER HEATER		421	11.2	1	8.16	8.10	
44	EXTRUDER MAIN MOTOR	18	419	12.4	0.84	8.88	11.97	66.50
45	SUPPLY AIR FAN -2	75	407	71	0.68	50.04	35.01	46.68
46	RETURN AIR FAN-2	75	404	63	0.58	44.70	28.20	37.60
47	RECYCLE AIR FAN -K-510	37	407	51.5	0.82	36.99	32.10	86.76

APPENDIX - 4/2

STAR MODE OPERATING UNDERLOADED MOTORS

The following motors should be tried for operating in star mode.

Sl.No	Motor/ Application	Rated kW	Measured kW	% Load
1	Take up return Air fan-1 *	75	21.9	29.2
2	Take up supply air fan-1	75	29.434	39.1
3	Root &blower B-601	15	4.5	30
4	Root & blower B-603	30	8.1	27
5	Wet Chip Transfer Blower-1	45	18.42	40.9
6	AHU spin drawn 604B	5.5	1.7	31.11
7	Supply air fan-2	75	35.1	46.6
8	Return air fan-2	75	28.2	37.6

* Already operating in star mode

APPENDIX - 4/3

POY - OPTIMUM SIZING AND USE OF HIGH EFFICIENCY MOTOR

APPLICATION	RATED kW	MEASURED. kW	PROPOSED HIGH EFF MOTOR KW	OPERT. HRS	SAVINGS kWh	COST SAVINGS Rs	INST. COST Rs.
C .T . Fan 1	30.0	28.50	30.0	8000	13223	56596	46860
C.T . Fan 2	30.0	25.20	30.0	8000	11993	51329	46860
Chilled Water P No 2	67.5	31.50	67.5	6000	15093	64599	93000
Compressor No 4	110.0	87.90	110.0	6000	31828	136224	120000
C . T . Pump No 3	55.0	45.30	55.0	6000	16256	69577	72000
Quench A/W Sup Fan 2	110.0	73.80	110.0	4500	21442	91773	
Quench A/W Sup Fan 2	110.0	73.80	110.0	8000	38119	163151	170000
Take up Circ. Pump No 1	75.0	21.90	75.0	8000	20290	86841	100000
Take up .... Air Fan 1	5.5	4.44	5.5	8000	2137	9146	9000
Lab A/ W Fan 1	30.0	16.38	22.0	8000	11059	47333	46860
~~Take Sup. Air Fan 1~~	~~75.0~~	~~29.43~~	~~75.0~~	~~8000~~	~~21364~~	~~91436~~	100000
Quench Circ. Pump 2	18.5	10.89	18.5	8000	6012	25730	30000
D. T. Room 2 A H U B	7.5	4.50	7.5	8000	2458	10521	12000
Inv Room - 2 A/W	15.0	9.60	15.0	8000	5071	21706	24150
Air Dryer Plant No 3	21.0	19.50	21.0	8000	9080	38864	30000
Circ. Blower	37.0	27.76	37.0	8000	13691	58599	59600
Paddle Dryer	30.0	13.80	30.0	8000	8906	38116	46860
Chips Blower	45.0	22.20	45.0	8000	13656	58449	60000
N2 Blower B - 601	11.0	4.50	11.0	8000	3164	13542	12000
Roots Blower B- 601 *	15.0	4.50	15.0	8000	4073	17432	24150
Roots Blower B- 603 *	30.0	8.10	30.0	8000	8039	34406	46860
Reclycl Air Fan- Rosing	37.0	32.43	37.0	8000	15274	65372	59600
Compressor No 3	110.0	90.00	110.0	6000	32359	138495	120000
C.T.Pump P 203 - A	15.0	11.22	15.0	6000	4155	17783	24150
Chiller Water Pump No 3	67.0	58.20	67.0	6000	20601	88171	104600
Wet Chip Tsfr Blower No	45.0	18.42	45.0	6000	9709	41555	60000
Wet Chip Tsfr Blower No	45.0	26.16	45.0	6000	10907	46682	60000
Booster Comp - 1	37.5	23.25	37.5	6000	9361	40067	59600
Booster Comp - 2	37.5	23.82	37.5	6000	9473	40545	59600
AHU Spin Draw 604 B	5.5	1.71	5.5	6000	1126	4818	9000
Refrig. Unit Chiller 601	55.0	24.60	55.0	6000	12146	51985	72000
Primary Chiller Prime Pu	5.5	5.10	5.5	6000	1782	7625	9000
Sec Chiller Prime Pump	5.5	5.16	5.5	6000	1799	7700	9000
Air Compressor 607	45.0	38.70	45.0	6000	13731	58769	60000
Cond W.P - 608	11.0	8.70	11.0	6000	3160	13527	24000
Spin Draw Exh. Fan	5.5	3.27	5.5	4500	1010	4322	9000
Extruder Main Motor	18.0	11.97	18.0	4500	3492	14946	30000
Extruder Heater						0	
Supply Air fan -2 *	75.0	35.01	75.0	4500	12579	53837	100000
Return Air Fan - 2	75.0	28.20	75.0	4500	11906	50959	100000
Recycle Air Fan K - 510 *						0	
Recycle Air Fan K - 510	37.0	32.10	37.0	4500	8524	36483	59600
Return Air Fan - 2	75.0	28.20	75.0	4500	11906	50959	59600
					471956	20,20,160	22,40,000

*** Star Mode operation of these motors are recommended**

Simple payback period = 1.1 years

APPENDIX - 4/4

THERMOSTATIC CONTROLLER FOR CT FAN-1 OR 2

The CT fan 1 & 2 are installed with 2 speed motors and manual changeover for different speeds

	Motor Rating kW	Actual Power drawn kW	
		High Speed	Low Speed
CT Fan-1	30	25.2	3.3
CT Fan-2	30	28.5	3.66

- ⇨ Presently the above speed changeover is carried out seasonably and this is recommended to carried out with automatic controls.
- ⇨ The proposal envisages installing temperature sensing system for cooling tower outlet temperature and two speed starter with controlling fort the motor drive.
- ⇨ It is estimated after discussions that motor is operated at low speeds for about 3 months in a year.
- ⇨ From above proposal it is estimated that energy savings by automatic speed changeover is expected to yield energy savings for additional 1000hrs in a year. (to bring low production/low ambient seasons of year)

Annual energy savings	= 1000 x (25.2 - 3.3) = 21,900 kWh
	= Rs. 93,732/-
Cost of Implementation	= Rs. 30,000
Payback period	= 0.32 years.

APPENDIX - 4

INVERTER PARAMETERS

PLANT : P O Y

Sl.No	Inverter Application	Rated kVA	Measured Parameters				
			V_L	I_L	P.F	kVA	kW
1	INVERTER FOR EXTRUDER-2	110	243	39.9	1	27.3	22.5
2	INVERTER M.P. 2INVERTER.	33	243	10.8	0.99	7.53	6.03
	OIL METERING	12.5	242	4.5	1	2.94	1.8
3	INVERTER GREVER POWR-2	82	243	39.6	1	21	12
4	INVERTOR GODET ROLL POWER-2	50	242	19.7	0.86	14.7	11.7
5	INVERTER FRICTIONS POWER-2	82	242	47	0.99	30.18	18.27
6	INVERTER EXT -3	110	243	34.9	1	24.15	18.9
7	INVERTER M.P. POWER -3	33	243	11.4	1	7.68	5.19
8	INVERTER OG.POWER -3	12.5	243	2.3	1	1.5	1.8
9	INVERTER GROV. POWER-3	50	241	15.9	0.92	12	7.62
10	INVERTER FR -3	82	241	42.4	1	29.7	15.6
11	INVERTER EXTR.4		241	60.7	1	41.4	31.5
12	INVERTER M.P.-4		242	8.6	1	6.21	5.34
13	INVERTER OG.POWER -4		242	1.7	1	1.47	1.08
14	INVER GRV. POWER-4					0	0
17	INVERTER GROV POWER-4		241	35.1	1	24.6	13.2
18	INVERTER FR.POWER-4		241	53.1	0.96	39	20.7
19	INVERTER M.P -5	44	237	15.9	0.95	11.1	5.4
20	INVERTER OG -5	44	237	1.9	1	1.68	1.56
21	INVERTER GR -.5	44	237	14.7	1	10.5	6.6
22	INVERTER GRV. -5	65	237	25.7	1	17.1	9.9
23	INVERTER FR. -5	120	237	46.2	0.91	31.8	17.1
24	EXTRUDER INV. 5	120	238	41.4	0.68	27.6	19.8
25	INVERTER GRV - IV		243	35.2	1	25.8	12.6
26	INV. FR - 4		242	57.9	0.89	42	17.4
27	INV. GR. - 4		257	18.6	1	14.1	8.1
28	INV. EXTR. HEATER-1	63.2				0	0

VARIOUS READING OF GRV, GR AND FR INVERTERS (M/C-1) AT IN/OUT SIDE

Sl. No	Voltage V	Current A (3φ)	Power factor cosφ (3φ)	Power kW (3φ)	kVA	ω1	ω2	ω3	Hz	Time	Invertor Panel Reading	Remarks
A. Groove Roll Inverter M/C.1 (Machine running without Yarn) Date 31/7/96												Total 24 postitions; only 23 positionsrunning
1	422	660 MA to 11.6 A	+0.32 to+0.76	293 W to 6.41 kW	526 VA to 8.28 kVA	0.15 kW to 3.4 kW	2.77 kW to 11.6 kW	0.8 W to 2.6 kW	49.9	3.00 P.M	V=311;Hz=175; I=21.1A/31.2A	Inverter operating with wobbulation V/F=1.8
2	422	5.42 A to 10.8 A	-0.87 to +0.76	3.34 kW to 3.58	4.17 kVA to 4.68 kVA	1.76kW to 1.78 kW	0.27 kW to 0.38kW	1.28kW to1.45kW	49.9	3.10 P.M	V=311;Hz=175, I=22.9/23.1A	Inverter operating with wobbulation V/F=1.8
3	422	5.64 A to 10.0 A	-0.85 to +0.76	3.4 kW 3.59kW	3.93 kVA to 3.59 kVA	1.72 kW to 1.85kW	0.39 kW to 0.45kW	1.26kW to 1.38kW	49.9	3.25 P.M	V=296;Hz=175, I=22.9/23.5A	Inverter operating with wobbulation V/F=1.7
4	422	338MA to 11.8	-0.43 to +0.77	140 W to 6.63 kW	0 to 8.57 kVA	0 to 3.41 kW	0 to 3.41 kW	0 to 2.46 kW	49.9 to 50	3.45 P.M	V=296;Hz=175, I=19.3/29.5A.	Inverter operating with wobbulation V/F=1.71
B Friction of Inverter Machine#1 (Machine running without yarn) Date 01.08.96												
1	422	12.6 A to 24 A	-0.83 to +0.84	7.68kW to 7.9kW	9.2kVA to 17.4kVA	2.53kW to 2.56kW	2.52kW to 2.72kW	2.53kW to 2.64kW	49.9	10.00 A.M	V/F=2.5;VAC (out)293 IAC(out)=10.6A;Hz=117 .92	Total 24 position; only 23 positions running
2	422	12.4A to 24A	-0.82 to +0.83	7.48kW to 7.35kW	8.93kVA to 9.35kVA	2.3kW to 2.48kW	2.34kW to 2.59kW	2.41kW to 2.59kW	49.9	10.16 A.M	V/F=2.38;VAC (out)293 IAC(out)=12.2A;Hz=117 .92	
C Godet Roll Inverter M/C#1 (Machine running without yarn) Date 01.0896.												
1	423	14.7Ato 22.2A	0.65 to 0.95	10.2kW to 10.5kW	15.2kVA to 16.0kVA	3.25kWto 3.62kW	3.02kW to 3.47kW	3.4kW to 3.87kW	49.9	10.45 A.M	V/F=2.6;VAC(out)=350 IAC(out)=34A; Hz=110.1	
2	422	13.8A to 19.8A	0.67 to 0.94	9.42kW to 9.70kW	13.8kVA to 14.2kVA	3kW to 3.4kW	2.65kW to 3.1kW	3.2kW to 3.67kW	49.9	11.29 A.M	V/F=2.46;VAC (out)=335 IAC(out)=30A; Hz=110.1	

APPENDIX - 5/1

DESIGN SPECIFICATION OF REFRIGERATION MACHINES

Sl. No	Description	Unit	Blue Star	Voltas
	No. of Installed		Two	One
	Nos. Operated		One	
	Type of Machine		Centrifugal Chiller	
01	Capacity,	TR	600	585
02	Input Power,	kW	420	450
03	Machine wise running hours year	h		
04	Design Parameters			
a	Min. inlet pressure or refrigerant	kg/cm^{2}g	Evaporating temp. -2 °C	-42mm Hg.
b	Max. discharge pressure of refrigerant	kg/cm^{2}g	Condensing temp 41.2°C	0.85
c	Chilled water In/Out temperature	°C	13.9°C/6.7	12°C/7
d	Chilled water In/Out pressure Δp	kg/cm^2 g	14.4 ft.	1:5 kg/cm^{2}g
e	Condenser In/Out temperature	°C	33.93°C/37.8 °C	33°C/38°C
f	Condenser In/Out pressure Δp	kg/cm^{2}g	21.6 ft. *	1.0 kg/cm^{2}g

* Design cooling water flow : 499 m^3/h

Chilled water flow : 259 m^3/h

Appendix 5/1 contd.

Sl. No	Description	Jyoti	Pump-2	TOP Spray Pump	Quench Spray Pump
I	**CHILLED WATER PUMP**				
				Kirloskar KDP 150/32N	Kirloskar KDP 125/32
01	Nos. installed	Three		Two	Two
02	Nos. operated	One		One	One
03	Design Flow, Nm^3/h	550		235	135
04	Design Head, MLC	30		25	25
05	Hours of operation per year	8760		8760	8760
06	Efficiency %	87%		77%	73 % 1450 rpm, motor 26kW
II	**CONDENSER PUMP**				
		Kirloskar (New)	KPD 125/26		
01	Nos. installed	Two	Two		
02	Nos. operated	One	One during summer		
03	Design Flow, Nm^3/h	670	180		
04	Design Head, MLC	20	20		
05	Hours of operation per year	8760			
06	Efficiency %	84.86%	81%		

APPENDIX - 5/2

SAMPLE OBSERVATION ON REFRIGERATION MACHINES

BLUE STAR : CENTRIFUGAL

Time	Pressure		Flow	Chilled Water				Vane	Comp
	Suction	Discharge	m^3/h	Temperature °C		Pressure (kg/cm^2g)		Opening	
				Inlet	Outlet	Inlet	Outlet	%	Amps
10.00	-12 in Hg Vac	5 psig	0.795 x 350	14.0	10.6	1.25	0.7	37.5	48
	-12 in Hg Vac	5 psig	0.80 x 350	14.0	10.0	1.25	0.7	38.0	48
	-12 in Hg Vac	5.2 psig	0.76 x 350	15.0	10.5	1.25	0.7	37.5	48
	-11.8in Hg Vac	5.4 psig	0.635 x 350	14.8	11.8	1.25	0.7	37.5	48
Avg.	-12 in Hg	5.15	261	14.45	10.725	1.25	0.7	37.5	48

Time	Condenser Water					Remarks
	Flow m^3/h	Temperature (°C)		Pressure kg/cm^2g		
		Inlet	Outlet	Inlet	Outlet	
10.00	0.51 x 700	29.0	31.5	2.8	2.3	i. 4m/cs Run; Total 7m/c; one chiller
11.15	0.51x 700	29.0	31.2	2.8	2.3	for all 7 m/c; Heater Load on for 3/mcs
13.45	0.52x700	29.0	31.7	2.8	2.3	even when not running; Motor Load off
15.15	0.515x700	29.2	32	2.8	2.3	ii. Difference in energy meter reading
Avg.	360	29	31.6	2.8	2.3	for 8 hrs. 1600 kWh, Avg. Compressor power consumption 200 kW

APPENDIX - 5/3

ESTIMATION OF REFRIGERATION LOAD AND SPECIFIC POWER CONSUMPTION

A. BLUE STAR CENTRIFUGAL MACHINE

i	Average Chilled water flow	= 261 m^3/h
ii.	Temperature drop across chiller	= 3.725°C
iii.	Tons of refrigeration	$= \frac{261 \times 1000 \times 3.725}{3000}$
		= 324 TR
iv.	Rated TR	= 600 TR
v	% Loading	$= \frac{324}{600} = 54$

B. ESTIMATION OF SPECIFIC POWER CONSUMPTION

i	Condenser Pump power input	= 45.3 kW
ii.	Compressor power input	= 200 kW
iii.	Chilled water pump	= 55.5 kW
iv.	C.T.Fan 1 & 2	= 25.2 kW
		= 326 kW
v.	Specific power consumption	$= \frac{326}{324}$
		= 1. 00kW/TR

APPENDIX- 5/4

REFRIGERATION LOAD CALCULATIONS

1.0 REF LOAD USER : TAKE UP AIR WASHER

2.0 MEASURED CONDITIONS

Sl.No	Location	Air flow m^3 / h	D B T °C	W B T °C	Remarks
1	Before Chiller Spray	144486	25	21.5	-
2	After Chiller Spray	144486	19	19	-

3.0 LOAD ANALYSIS

3.1 CALCULATIONS

Date	Flow m^3/h	Avg. sp.vol before Chiller m^3/kg	Avg. sp moisture before chiller spray	Avg. sp moisture after chiller spray	* Sensible Heat Load TR	** Latent heat Load TR	Total Load TR
26.07.96	144486	0.865	0.0148	0.0138	80	30	110

* {(m^3/h flow / sp. vol before chiller spray) x DBT difference across chiller x 0.24/3000) TR}

** {(m^3/h flow / sp. vol before chiller spray)xsp. moisture diff.x540/ 3000) TR}

3.2 A/C conditions required in the Department

		D B T °C	RH %
Desired Values		25 ± 1	65 ± 5
Avg. measured value	M/C1	27.2	65
	M/C2	29	65
	M/C 3	29	60
	M/C4	30	57
	M/C5	27.5	65
	M/C6	25.8	66

APPENDIX - 5/5

REFRIGERATION LOAD CALCULATIONS

1.0 REF LOAD USER : QUENCH AIR WASHER

2.0 MEASURED CONDITIONS

Sl.No	Location	Air flow m^3 / h	D B T ° C	W B T ° C	Remarks
[illegible]	Before Chiller Spray	79092	33.5	23.5	-
2	After Chiller Spray	79092	19	19	-

3.0 LOAD ANALYSIS

3.1 CALCULATIONS

Date	Flow m^3/h	Avg. sp.vol before Chiller m^3/kg	Avg. sp moisture before chiller spray	Avg. sp moisture after chiller spray	* Sensible Heat Load TR	** Latent heat Load TR	Total Load TR
26.07.96	79092	0.889	0.0142	0.0138	103	6.4	109.4

* {(m^3/h flow / sp. vol before chiller spray) x DBT difference across chiller x 0.24/3000) TR}

** {(m^3/h flow / sp. vol before chiller spray)xsp.moisture diff.x540/ 3000) TR}

3.2 A./C conditions required in the Department

	D B T	RH
Desired values	15 ± 1	100%
Avg measured value	* 20.2	92%

* Presently higher temperature is maintained

3.3

	D B T	W B T
Before quenching	20.2	19.2
After quenching	26.1	21.5

APPENDIX - 5/6

REFRIGERATION LOAD CALCULATIONS

1.0 REF LOAD USER : DANIER TESTING ROOM

2.0 MEASURED CONDITIONS

Sl.No	Location	Air flow m^3 / h	D B T °C	W B T °C	Remarks
1	Before Chiller Spray	29573	26	24	-
2	After Chiller Spray	29573	23.5	21.5	-

3.0 LOAD ANALYSIS

3.1 CALCULATIONS

Date	Flow m^3/h	Avg. sp.vol before Chiller m^3/kg	Avg. sp moisture before chiller spray	Avg. sp moisture after chiller spray	* Sensible Heat Load TR	** Latent heat Load TR	Total Load TR
30.07.96	29573	0.872	0.018	0.0153	6.8	16.5	23.3

* {(m^3/h flow / sp. vol before chiller spray) x DBT difference across chiller x 0.24/3000) TR}

** {(m^3/h flow / sp. vol before chiller spray)xsp.moisture diff.x540/ 3000) TR}

3.2 A./C conditions required in the Department

	D B T (°C)	RH
Desired values	25 ± 1	65 ± 5
Avg measured value	25.25	85

REFRIGERATION LOAD CALCULATIONS

1.0 REF LOAD USER : INVERTER ROOM

2.0 MEASURED CONDITIONS

Sl.No	Location	Air flow m^3 / h	D B T ^oC	W B T ^oC	Remarks
1	Before Chiller Spray	34,168	25.5	21.5	-
2	After Chiller Spray	34,168	20	18.5	-

3.0 LOAD ANALYSIS

3.1 CALCULATIONS

Date	Flow m^3/h	Avg. sp.vol before Chiller m^3/kg	Avg. sp moisture before chiller spray	Avg. sp moisture after chiller spray	* Sensible Heat Load TR	** Latent heat Load TR	Total Load TR
30.07.96	34168	0.865	0.0145	0.0128	17.4	12.1	29.5

* {(m^3/h flow / sp. vol before chiller spray) x DBT difference across chiller x 0.24/3000) TR}

** {(m^3/h flow / sp. vol before chiller spray)xsp.moisture diff.x540/ 3000) TR}

3.2 A./C conditions required in the Department

	D B T (^oC)	RH %	Remarks
Desired values	26± 1	No RH control	
Avg measured value	26.9	-	Inverter room
	29.7	-	Extruder
			Spin block

APPENDIX - 5/8

REFRIGERATION LOAD CALCULATIONS

1.0 REF LOAD USER : TEXTILE LAB

2.0 MEASURED CONDITIONS

Sl.No	Location	Air flow m^3 / h	D B T ^oC	W B T ^oC	Remarks
1	Before Chiller Spray	13,907	26.2	22.4	-
2	After Chiller Spray	13,907	* 25.5	22	-

* At Department

3.0 LOAD ANALYSIS

3.1 CALCULATIONS

Date	Flow m^3/h	Avg. sp.vol before Chiller m^3/kg	Avg. sp moisture before chiller spray	Avg. sp moisture after chiller spray	* Sensible Heat Load TR	** Latent heat Load TR	Total Load TR
30.07.96	13907	0.869	0.0156	0.0152	1	1.1	2.2 *5 .0 TR)

* Considering temperature rise in the department

* {(m^3/h flow / sp. vol before chiller spray) x DBT difference across chiller x 0.24/3000) TR}

** {(m^3/h flow / sp. vol before chiller spray)xsp.moisture diff.x540/ 3000) TR}

3.2 A./C conditions required in the Department

	D B T ^oC	RH%
Desired values	25 ± 1	65 ± 3
Avg measured value	25.5	66

APPENDIX - 6/1

COMPRESSOR SPECIFICATIONS

Description	Comp	Comp	Comp
Identification code	-	-	(Booster)
Make	K G Khosla	I.R	K G Khosla
No. of stages	2	2	1
Design pressure kg/cm^{2}g	8.5	8.78	16
Motor rating kW	110	200	37
FAD m^3/min	17.25	28.13 at* 750 rpm	3.54
Motor speed rpm	1485	1485	1480
Transmission type	Belt	Belt	Belt
No. of belts	Four	Nine	Three
Speed	710	620	540
Hours operated/year	Continuous	Continuous	Not used at prese
No. of compressors	5	2	2
No. of compressors normally operated	2	1	0

* FAD at 620 RPM = 23.25 m^3/min
Actual 608 RPM

APPENDIX - 6/2

FREE AIR DELIVERY (FAD) TEST

Sl. no.	Particulars	Unit	Compressor						
			Comp.# 1	**Comp.# 2**	**Comp.# 3**	**Comp.# 4**	**Comp.# 5**	**Comp.# 6**	**Comp.# 7**
1	Identification code		KGK # A	KGK # B	KGK # C	KGK # D	KGK # E	IR # A	IR # B
2	Compressor application		Process	Process	Process	Process	Process	Process	Process
3	Compressor make		KGK	KGK	KGK	KGK	KGK	IR	IR
4	Compressor type		Non-lub	Non-lub	Non-lub	Non-lub	Non-lub	Non-lub	Non-lub
5	No of stages	Nos.	2	2	2	2	2	2	2
6	Motor rating	kW	110	110	110	110	110	200	111
7	Design free air delivery	m^3/min	17.25	17.25	17.25	17.25	17.25	23.25	23.25
		m^3/h	1035	1035	1035	1035	1035	1395	1395
8	Suction details								
	Filter width	m	0.46	0.46	0.44	0.44	0.44	0.56	0.436
	Filter breadth	m	0.46	0.46	0.44	0.45	0.45	0.56	0.43
	Suction c/s area	m^2	0.21	0.21	0.19	0.20	0.20	0.31	0.19
9	Suction air velocity	m/sec	1.22	1.23	1.44	1.41	1.43	1.01	1.85
10	Compressor actual FAD	m^3/sec	0.26	0.26	0.28	0.28	0.28	0.32	0.35
		m^3/h	929.35	936.96	1003.62	1005.05	1019.30	1140.25	1248.62
		m^3/min	15.49	15.62	16.73	16.75	16.99	19.00	20.81
11	**Percentage FAD**	%	**89.79**	**90.53**	**96.97**	**97.11**	**98.48**	**81.74**	**89.51**

Free Air Delivery of R&D Compressor

Compressor Make	=	Kirloskar
Identification Code	=	R&D Compressor
Compr. application	=:	Process & Instrumentation
Compr. type	=	Non-Lub reciprocating
No of stages	=	2
Motor rating	=	45 kW
Design free air delivery	=	5.7 m^3/min 342m^3/h
Compressor receiver volume+piping	=	6.06 m^3
Time taken to fill the receiver	=	12.16 min
Intial receiver pressure	=	1 kg/cm^2a
Final receiver pressure	=	10.8 kg/cm^2a
Free air delivery of compressor	=	4.88 m^3/min
Percentage Fad	=	85.61%

FAD of compressor, m^3/min = (Final pressure -Initial pressure) x Receiver vol / (atm pressure x time)

APPENDIX - 6/3

EFFICIENCY EVALUATION

Sl. no.	Particulars	Unit	Compressor							
			Comp.#1	Comp.#2	Comp.#3	Comp.#4	Comp.#5	Comp.#6	Comp.#7	Comp.#8
1	Identification code		KGK # A	KGK # B	KGK # C	KGK # D	KGK # E	IR # A	IR # B	R&D
2	Compressor application		Process	Process	Process	Process	Process	Process	Process	Process
3	Compressor make		KGK	KGK	KGK	KGK	KGK	IR	IR	KPL
4	Compressor type		Non-lub	Non-lub	Non-lub	Non-lub	Non-lub	Non-lub	Non-lub	Non-lub
5	Rated power	kW	110	110	110	110	110	200	200	45
6	No of stages	Nos.	2	2	2	2	2	2	2	2
7	Actual Power	kW	101.4	99	100.2	94.2	97.5	152.4	136.8	38.7
8	Actual free air delivery	m^3/h	929.35	936.96	1003.62	1005.05	1019.3	1140.25	1248.6	292.8
		m^3/min	15.49	15.62	16.73	16.75	16.99	19.00	20.81	5.33
9	Suction pressure	kg/m^2a	10000	10000	10000	10000	10000	10000	10000	10000
10	Discharge Pressure	kg/m^2a	85000	85000	85000	82000	82000	85000	85000	105000
11	No of inter coolers	Nos.	1	1	1	1	1	1	1	1
12	Adiabatic Constant	m^2	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40
13	Theorotical power req.	kW	63.36	63.87	68.42	67.18	68.14	77.73	85.12	24.34
14	**Compressor Efficiency**	%	**62.48**	**64.52**	**68.28**	**71.32**	**69.88**	**51.01**	**62.22**	**57.88**

APPENDIX - 6/4

OPERATING PARAMETERS

Sl.no.	Particulars	Unit	Compressor							
			Comp.#1	Comp.#2	Comp.#3	Comp.#4	Comp.#5	R & D	Comp.#6	Comp#7
1	Identification code		KGK # A	KGK # B	KGK # C	KGK # D	KGK # E	R&D com	IR # A	IR # B
2	Compressor application		Process	Process	Process	Process	Process	Process	Process	Process
3	Compressor make		KGK	KGK	KGK	KGK	KGK	KPL	IR	IR
4	Compressor type		Non-lub	Non-lub	Non-lub	Non-lub	Non-lub	Non-lub	Non-lub	Non-lub
5	No of stages	Nos.	2	2	2	2	2	2	2	2
6	Motor rating	kW	110	110	110	110	110	45	200	200
7	Design free air delivery	m^3/min	17.25	17.25	17.25	17.25	17.25	5.7	23.25	23.25
	Operating parameters									
1	Stage pressures	kg/cm^2g								
	I Stage		2	1.5	2.4	1.6	1.9	3	1.7	1.5
	II Stage		8.1	8.1	8.4	8.4	8.4	9.6	8.4	8.4
2	Receiver Pressure settings	kg/cm^2g								
	Loading		7.1	7.1	7.1	7.1	7.1	8.5	7.1	7.1
	Unloading		8	8	8	8	8	9.8	8	8
3	Temperatures before cooler	°C								
	I Stage		135	145	124	130	112	-	130	130
	II Stage		150	160	105	124	100	115	160	140
4	Temperatures After cooler	°C								
	I Stage		38	38	30	37	33	28	55	52
5	Outlet water temperature	°C	30	30	30	30	30	34	35	30
6	Inlet water temperature	°C	27.8	27.8	27.8	27.8	27.8	27.8	27.8	27.8

Remarks : POY has seven compressors out of which two/three will be in operation
First stage outlet temp of IR is varying 50-55° C (after intercooler) is high
May be due to- corroded baffles

APPENDIX - 6/5

USE OF BLOWER AIR FOR DRYING THE CHIPS IN NARA AND ROSIN MACHINES

Compressed air to the dryers is supplied at 7- 8 kg/cm2g reduced to 800mmwg though PRV. This low pressure air is used for chip drying to drive away the moisture in the chips. Since the air is used at low pressure it is felt that that blower air can meet the process requirments. Air can be generated at 2000 mm wg and this air can be passed through the dryer (silica gel/ Activated alumina) and then used in the chip dryers.

Existing system uses compressors to generate air at 7-8 kg/cm2g and heat of compresson dryer for moisture removal. In the proposed system blower and external heated dryers are required. During the evaluation of feasibility the power consumed by blower and heaters are considered. The type of dryer considered is blower reactivated.

Present System :

Requirement of air

Rosin dryer # 1	:	400 m^3/h
Rosin dryer # 2	:	400 m^3/h
Nara dryer		400 m^3/h
Total	:	1200 m^3/h
Power consumption	:	10 kW/(100m^3/h)
Total Power consumption	:	120 kW

Proposed system : Having a Blower to generate air at low pressure and passing through dryer

Power consumption in the Blower

Air requirement	:	1200 m^3/h	
Capacity of blower required	:	1800 m^3/h	
Blower air pressure	:	200 cmwg	
Air consumption (Peak)	:	1800 m^3/h	(50%above the normal)
Blower efficiency	:	0.5	
Blower power consumption	:	19.58 kW	

Appendix - 6/5 contd..

Power Consumption in the dryer heaters and dryer blower for 1800 m^3/h

Power consumption in dryer : 15.00 kW/(1000 m^3/h)
Total power consumption : 27 kW

Total Power consumption (Dryer + Blower) : 46.58 kW
Specific power consumption : 2.59 kW/(100m^3/h)

Savings
:
Savings in Specific Power : 7.41 kW/(100m^3/h)

Dryer	Air Cons.	Power Consumption kW		Savings	Operating	Annual Savings	
	m^3/h	Present	Proposed	kW	hours/y	kWh	Rs
ROSIN # 1	400	40	10.35	29.65	8000	237184	1015147.5
ROSIN # 2	400	40	10.35	29.65	-	-	-
NARA	400	40	10.35	29.65	8000	237184	1015147.5
					Total	474368	2030295.0

Total annual energy savings : 474368 kWh
Annual cost savings : Rs.2030295.0/year

Investment
Investment is required for two blower (one standby), one dryer and piping
Cost of investment : Rs.15,00,000
Payback period : o.73 years

Blower power consumption : (2.72 x flow x pressure)/(efficiency x 10000

Flow in m3/h
Pressure in cm wg

APPENDIX - 6/6

USE OF LOW PRESSURE AIR IN YARN INTERLACING OF POY SPINNING MACHINES NO. 5 AND 6

In POY spinning machines no. 5 and 6 compressed air is used at 1.1 kg/cm^{2}g to strength the yarn by noding. Compressed air which is supplied at 7-8 kg/cm2g is reduced to 1.1 kg/cm^{2}g Since the air is used at low pressure a seperate compressor to genarate air at 2.2 kg/cm^{2}g can be installed.

Present System :

Requirement of compressed air	:	900 m^3/h (in both machines no. 5 & 6
Power consumption	:	10 kW/(100m^3/h)
Total Power consumption	:	90 kW

Proposed system : Having a separate compressor to generate air at 2.2 kg/cm^{2}g

Required pressure	=	2.2 kg/cm^{2}g
Compressed air required	=	15 m^3/min
Suction pressure	=	10000 kg/m^{2}a
Discharge Pressure	=	22000 kg/m^{2}a
Adiabatic Constant	=	1.40
Theorotical power req.	=	21.67 kW
Compressor efficiency	=	0.60
Total power required	=	36.12 kW

Dryer (heater) power required	=	14 kW
Total Power	=	50.12 kW

Appendix - 6/6 contd..

Savings:

Savings in energy	=	39.88 kW
Annual savings in energy @ 6000 hours/year	=	239280 kWh
Cost savings	=	Rs.1024118/y
Investment required (For compresser & dryer)	=	Rs.15,00,000/-
Simple payback period	=	1 year 7 months

Salient features:

1. Use of separate compressor for yarn interlacing avoids one compressor operation
2. Investment is required for a compressor of capacity 1000 m^3/h and piping
3. Separate dryers should be installed. Since the compressed air pressure is 2.2 kg / wg only external heating type of dryer should be installed.

APPENDIX - 7/1

STEAM UTILISATION AREAS

Sl No.	Equipment	Purpose	Steam Pressure kg/cm^2	Steam Quantity kg/hr	Remarks
1	Rosin dryer - II Main Line Air Recycle	To heat fresh Air	16.5 17.0	24 175	Continious Continious
2	Nara Dryer HP line	To heat fresh Air	17.0	110	Continious
3	Paddle dryer (Nara)	To heat vent Air from nara	5.0	150	Continious
4	Salt bath	Prepare salt bath	3.5	-	1 hour per day
5	Washing	Spin Pack blocks	3.5	-	Small quality
6	Finish oil tank	To prepare finish oil	3.5	-	Small quality

APPENDIX - 7/2

MEASURED SURFACE TEMPERATURES OF EQUIPMENT AND DISTRIBUTION LINES

Sl No.	Equipment	Heating Media	Surface Temp.°C
1	Rosin dryer-II	Steam	40
2	Air filter (Nara)	Hot air	38
3	Fluidised bed (inlet Temp.)	Hot air	145
4	Paddle Dryer (Nara)	Steam	40
5	Recycle Air heater	Steam	51
6	II nd floor HP line	Steam	58
7	Ist floor HP line	Steam	51
8	HP line between Ist and ground floor	Steam	53
9	Recycle Air heater (Nara)	Steam	36
10	Recycle Airheater line Temp.	Steam	51
11	Recycle Air heater	Steam	54
12	Salt Bath	Elec. heater	90

APPENDIX - 7/3

SURFACE HEAT LOSSES FROM UNINSULATED FLANGES, VALVES AND PIPELINES

Sl No	Location	Particulars	Nos	Dia in inches	Temp ^0C	Eq.l, m	Eq.area m^2 (total)	Heat loss kcal/h
1	Line to Paddle dryer at PRV	Pipe		1.05	186.00	1.00	0.08	1541.75
2	At Paddle dryer condensate line	Pipe		1.05	131.00	0.50	0.04	764.12
3	I Floor line	Pipe		1.99	103.00	20.00	3.17	2024.97
4	I Floor line	Flange	1	1.99	194.00	1.13	0.18	1800.29
5	I Floor at autocontrol valve	Pipe .		1.99	191.00	1.00	0.16	1720.38
6	I Floor line to Rosin I	Pipe		1.99	122.00	1.00	0.16	745.52
7	II Floor Recycle heater	Pipe		1.99	200.00	0.50	0.08	1772.25
8	Recycle heater Nara dryer	Flange	2	1.99	194.00	1.13	0.36	2036.44
	Total						**4.23**	**12405.72**

REDUCTION IN SURFACE HEATLOSS AFTER INSULATION

Sl No	Particulars	Location	Nos	Dia in inches	Eq.l, m	Eq.area, m^2 (total)	Heatloss, kcal/h	Surface temp, ^0c
GROUND FLOOR								
1	Line to Paddle dryer at PRV	Pipe		4.20	1.00	0.33	51.05	35
2	At Paddle dryer condensate line	Pipe		4.20	0.50	0.17	22.87	37
3	I Floor line	Pipe		5.14	20.00	8 20	747.57	35
4	I Floor line	Flange	1	5.14	1.13	0.46	93.15	43
5	I Floor at autocontrol valve	Pipe		5.14	1.00	0.41	80.95	43
6	I Floor line to Rosin I	Pipe		5.14	1.00	0.41	62.12	43
7	II Floor Recycle heater	Pipe		5.14	0.50	0.20	42.70	44
8	Recycle heater Nara dryer	Flange	2	5.14	1.13	0.93	186.29	43
	Total					**11.11**	**1286.70**	

Appendix - 7/3 contd..

Heat losses from uninsulated flanges, pipes and valves	= 11119.02 kcal/h
Heat losses after insulation	= 1286.07 kcal/h
About 80% of the savings can be realised	
Coal calorific value	= 3800 kcal/kg
No. of operating	= 6000 hours/year
Coal saving	= 12.42 tons/year
Cost of coal	= Rs.1800/ton
Cost savings	= Rs.22357/year
Cost of insulation	= Rs.400/m^2
Total area of insulation	= 6.88 m^2
Investment required	= Rs.2752
Simple payback period	= 2 months

APPENDIX - 7/4

STEAM LEAKAGES

Date : 29.07.96

Ambient air temp. : 32°C

Sl No.	Location	Nos.	Plume Length ft	Estimated Qty kg/hr	Remarks
1.	Recycle Air heater Nara dryer (Ground floor)	1	3	15.0	15 kg/cm^2 pressure
2.	Condensate line below Nara dryer	1	2	5.0	from condensate line steam leakage

Estimation of Energy Savings

Total steam loss due to leakages = 20 kg/hr

= 20 x 24 x 350

= 168 t/y

Cost of steam = Rs.467.97/t

Annual savings in Rupees = Rs.78619

Estimated Investment = Rs.20000

Simple payback period = 3 months

APPENDIX - 7/5

STEAM TRAP SURVEY

Date = 29.07.96

Ambient air temp. = 32°C

Sl No.	Location	Type	W/Nw	Remarks
1.	Rosin dryer-II HP line PRV to 5 kg/cm^2 line to Nara dryer	Thermo state	NW	2 Nos. Continious Steam flows
2.	At paddle dryer	Thermo state	NW	3 Nos. Steam Passing

* W - Working
NW - Not working

APPENDIX - 8/1

OBSERVATIONS ON COOLING TOWER PARAMETERS

A. MEASURED DATA

Time	Temperature of Cooling Water °C		Ambient, Temp. °C		Fan outlet temperature °C		Remarks
	Inlet	Outlet	DB	WB	DB	WB	
9.50	30.5	28.5	27.5	26.5	27.5	27 5	One CT
11.30	31	28.5	27.5	26.5	28.0	28.0	fan
15.30	32	28.5	27.5	26.5	28.5	28.5	running
Average	31.2	28.5	27.5	26.5	28	28	

B. RANGE AND APPROACH

Time	Range °C	Approach °C
9.50	2	2
11.30	2.5	2
15.30	3.5	2
Average	2.7	2

C. HEAT LOAD

I. Heat Load = Mass x Sp.heat x Temperature diff.

ii. Estimated condenser pump flow in Gallons per minute

$$= \frac{\text{Liquid Horse Power x 396}^{\circ}}{\text{Differential pressure/ft.}}$$

a. Condenser power input (measured) = 45.3 kW

$\eta_p \times \eta_m$ = 0.85 x 0.85

Appendix - 8/1 contd.

b. Liquid horse power $= \frac{45.3 \times 0.7225}{0.746}$

$= 44$ HP.

c. Flow in Gallons /minute $= \frac{44 \times 3960}{\text{(Differential pressure ft}}$

$= \frac{44 \times 3960}{2.1 \times 10 \times 3.3}$

$= 2514.$

d. Flow in (m^3/h) $= \frac{2514 \times 4.5 \times 60}{1000}$

$= 679\ m^3/h$

Estimated flow is almost to the designed value.

Heat Load $= 679 \times 1000 \times 1 \times 2.7$

≈ 1.83 million Kcal/h

Percentage Load on
Load on Cooling tower $= \frac{1.83}{3.69} \times 100$

$\approx 50\%$

APPENDIX - 9/1

LIGHTING DETAILS

PLANT : POY

Sl. No	Location	Lighting Fixture Type	Wattage of each (W)	Qnty. (Nos.)	Total Wattage (W)	Remarks
1	Chem. Store	Flame Proof Fitting	160	4	640	Separate Switch provided
2	POY Store (Rack)	High Bay fitting	160	4	640	Separate Switch provided
3	POY Store (Office)	IVE-24H	80	12	960	Separate Switch provided
4	Tech Office	Decorative (CRP-24H)	80	17	1360	Separate Switch provided
5	Physical Lab.	Decorative type (CPA-24H)	80	16	1160	Separate Switch provided
6	DGM (Cabin)	Decorative type (CPA-24H)	80	3	240	Separate Switch provided
7	POY substation	IVE-24H	80	26	208	Separate Switch provided
8	Battery Room	IDC-24H	80	3	240	Separate Switch provided
9	Transformer Room	IVE-24H	80	10	800	Separate Switch provided
10	Corridor # 1	IVE-24H	80	13	104	Separate Switch provided
11	Corridor # 2	IVE-24H	80	11	880	Separate Switch provided
12	Packing Section	IVE-24H	120	37	444	Separate Switch provided
13	Stitching Room	IVE-34H	80	40	320	Separate Switch provided
14	Intermediate Godown	IVE-24H	80	12	960	Separate Switch provided
15	Rest Room	IVE-24H	80	10	800	Separate Switch provided
16	WC Room	IVE-24H	80	4	320	Separate Switch provided
17	Sales Office	IVE-24H	80	7	560	Separate Switch provided
18	Sales Godown	IVE-24H	80	5	400	Separate Switch provided
19	Sales Godown	High Bay fitting (Type 1HB-251H)	160	10	160	Separate Switch provided
	Sales Godown	High Bay fitting (Type 1HB-251H)	250	11	275	Separate Switch provided
20	Cast Room	IVE-24H	80	7	560	Separate Switch provided
21	AHU Room	IVE-24H	80	3	240	Separate Switch provided
22	Balancing Room	IVE-24H	80	8	640	Separate Switch provided
23	Mech. Workshop	IVE-24H	80	12	960	Separate Switch provided

Sl. No	Location	Lighting Fixture Type	Wattage of each (W)	Qnty. (Nos.)	Total Wattage (W)	Remarks
24	Inst. Workshop	IVE-24H	80	8	640	Separate Switch provided
25	Elect. Workshop	IVE-24H	80	12	960	Separate Switch provided
26	Corridor #3	(I) IVE - 34H (ii) IVE_24H	120 80	6 4	720 320	Separate Switch provided
27	Denier Testing Room	IVE-24H	80	24+1	200	Separate Switch provided
28	T/up M/c # 1 to 4	IDC-24H	80	47	3760	Separate Switch provided for 12 fittings
29	Inverter Room (old)	IVE-24H	80	26	2080	Separate Switch provided
30	Inverter Room (New)	IVE-24H	80	23	1840	Separate Switch provided
31	Cable Corridor	IVE-24H	80	14	1120	Separate Switch provided
32	T/up M/c # 5 & 6	a) IDC-24H b) IDC-24H	80	9 23	720 1840	Separate Switch provided
33	SNIA M/c	a) IDC-24H b) IVE-24H	80	19 8	1520 640	Separate Switch provided
34	R/R (old)	IVE - 24H	80	3 + 2	400	Separate Switch provided
35	Spin Finish Oil Room	IVE-24H	80	11	880	Separate Switch provided
36	Old R/A (Ground)	IVE-24H	80	20	160	Separate Switch provided
37	New R/A (Ground)	IVE-24H	80	46	3680	Separate Switch provided
38	Ultrasonic Room	IVE-24H	80	4	320	Separate Switch provided
39	Burning Oven Room (Old)	IVE-24H	80	4	320	Separate Switch provided
40	Assembly Room (old)	IVE-24H	80	6	480	Separate Switch provided
41	Mech. workshop (old)	IVE-24H	80	4	320	Separate Switch provided
42	Production office	IVE-24H	80	5	400	Separate Switch provided
43	Corridor (old)	IVE-24H	80	6	480	Separate Switch provided
44	R/A (old) first floor	IVE-24H	80	21	1680	Separate Switch provided
45	(Old) R/A Air washer Room	IVE-24H	80	11	880	Separate Switch provided
46	(Old) R/A Staircase	IVE-24H	80	7	560	Separate Switch provided

Sl. No	Location	Lighting Fixture Type	Wattage of each (W)	Qnty. (Nos.)	Total Wattage (W)	Remarks
47	(New) R/A	IVE-24H	80	31	2480	-
48	New R/A Staircase	IVE-24H	80	6	480	Auto Switching
49	Terrace New Air Washer	a)IVE-24H b) IDC-24H c) SLT-24H	80 80 80	1 14 13	80 112 [illegible]	Auto Switching - -
50	Old R/A Terrace	SLT-24H	80	6	480	-
51	M/c Area 1 to 4	IDC-24H	80	46	3080	Separate Switch provided
52	M/c area 5 & 6	a) TDC-24H b) IVE-24H	80 80	33 3	2040 240	Separate Switch provided Separate Switch provided
53	Control Room of Spinning	IVE-24H	80	13	1040	Separate Switch provided
54	Salt Bath	IVE-24H IDC-24H	80 80	5 1	400 80	Separate Switch provided Separate Switch provided
55	Sand Prep. Room	IVE-24H IDC-24H	80 80	6 3	480 240	Separate Switch provided Separate Switch provided
56	Extruder Areas (1 to 4)	IDC-24H	80	30	2400	Separate Switch provided
57	Extruder Area (5 &6)	TDC-24H	80	14	1120	-
58	Spinneret Room	IVE-24H	80	9	720	Separate Switch provided
59	Salt Bath Hoist Room	IVE-24H	80	4	320	Separate Switch provided
60	Silo Area (1to4)	IDC-24H SLE-24H	80 80	4 6	320 480	Auto Switching Auto Switching
61	Silo Area (M/c # 5 &6)	IDC-24H SLE-24H	80 80	2+3 5	400 400	Auto Switching Auto Switching
62	SNIA (Spinning)	IDC-24H	80	13	1040	-
63	SNIA (Extruder)	IDC-24H	80	10	800	-
64	Rosin Dryer (Ground)	IVE-24H	80	16	1260	-
65	Rosin Dryer(First)	IVE-24H	80	11	880	Separate Switch provided in Control room
66	Rosin Dryer (Second)	IVE-24H	80	9	720	Separate Switch provided in Control room
67	Rosin Dryer (Third)	IVE-24H	80	11	880	Separate Switch provided in Control room
68	Nara Dryer (Ground)	IVE-24H	80	11	880	Separate Switch provided in Control room

Appendix 9/1 contd.

Sl. No	Location	Lighting Fixture Type	Wattage of each (W)	Qnty. (Nos.)	Total Wattage (W)	Remarks
69	Nara Dryer(First)	IVE-24H	80	14	1120	Separate Switch provided in Control room
70	Nara Dryer (Second)	IVE-24H	80	7	560	Separate Switch provided in Control room
71	Nara Dryer (Third)	IVE-24H	80	3	240	Separate Switch provided in Control room
72	Nara Dryer (Fourth)	IVE-24H	80	2	160	Separate Switch provided in Control room
73	Nara Dryer (Fifth)	IVE-24H	80	4	320	Separate Switch provided in Control room
74	Nara Dryer (Sixth)	IVE-24H	80	6	480	Separate Switch provided in Control room
75	Nara Dryer (Seventh)	IVE-24H	80	2	160	Separate Switch provided in Control room
76	Staircase of Nara Dryer	SLT-24H	80	5	400	Auto switching operation
77	Peripheral Lighting ckt at Transformer Room	SLT - 24H	80	4	320	Auto switching operation
78	Street Light	SS151H	150	12	1800	Auto switching operation

LIGHTING FIXTURE DETAILS OF R & D PLANT

Sl. No	Location	Lighting Fixture Type	Wattage of each (W)	Qnty. (Nos.)	Total Wattage (W)	Remarks
1	Silo Area	IVE-24H	80	07	560	Separate Switch provided
2	Nauta Mixture Area	IVE-24H	80	08	640	Separate Switch provided
3	Extruder Area	IVE - 24H	80	10	800	Separate Switch provided
4	Quench Area	IVE-24H	80	05	400	Separate Switch provided
5	AHU Room	IVE-24H	80	06	480	Separate Switch provided
6	Chips Storage Room	IVE-24H	80	05	400	Separate Switch provided
7	Chimney Room	IVE-24H	80	04	320	Separate Switch provided
8	Cooling Tower Area	SLT-24H	80	02	160	Separate Switch provided
9	Spindraw Room	CRL-24H	80	10	800	Separate Switch provided
10	Chips Dryer Room	IVE-24H	80	08	640	Separate Switch provided
11	Physical Lab. ARea	IVE-24H	80	10	800	Separate Switch provided
12	Prototype Area	IVE-24H	80	03	240	Separate Switch provided
13	R.A.& Utilisty Room	IVE-24H	80	09	720	Separate Switch provided
14	R&D Substation ARea	IVE-24H	80	07	560	Separate Switch provided
15	Chem. Lab Area	IVE-24H	80	04	320	Separate Switch provided
16	R&D Chief Cabin	CPA-24H	80	02	160	Separate Switch provided
17	Library Room	CPA-24H	80	02	160	Separate Switch provided
18	Inst. Toom	CPA-24H	80	02	160	Separate Switch provided
19	Rest Room	IVE-24H	80	03	240	Separate Switch provided
20	Tech. Office (R&D)	IVE-24H	80	04	320	Separate Switch provided
21	Corridor	CPA-24H	80	06	480	Separate Switch provided
22	Peripheral Lighting	a) SLT-24H b) IVE-24H	80 80	10 01	800 80	Automatic Switch provided
23	Staircase	IVE-24H	80	10	800	Separate Switch provided
24	Lift Room	IVE-24H	80	02	160	Separate Switch provided

APPENDIX - 9/2

LUX LEVEL MEASUREMENTS

PLANT : POY

DATE :01.08.96
TIME : 19.30 HRS.

Sl. No.	Location details	Lux Level in Lumen Measured	Remarks
1	Corridor between w/s & take up m/c	100	
2	Carton Storage	50	Can use single T/L Sodium lamps (2) can be used elsewhere
3	Denier Testing Room (North	100	
4	Denier Testing Room (South)	100	
5	T/U 1 to 4 M/C	500	234-235 Volts
6	T/U M/c. 1 & 2 back side	200	Normally swithched off
7	Inverter room 1 to 6	250	Normally switched off
8	Inverter room m/c back side	200	"
9	Lift frontage	100	
10	T/U 5 & 6	240	Twc.31 - Dust proof fitting
11	T/U 5 & 6 wall side	180	
12	T/U 5 & 6 Back side	180	
13	Staircase to T/U to Spg. (1st flr)	100	
14	Spg. m/c 5 & 6 front side	350	
15	Spg. m/c 5 & 6 back & wall side	100	
16	Extruder control romm	230 / 300	
17	Salt bath room		General shift work 'switched off'
18	Spg. 1 to 4 passage	150	
19	Spg. m/c front side	300	
20	Spg. m/c. back side	200	
21	Extruder 5 & 6 (South)	100	None working sep. sw/timer usage
22	Extruder 5 & 6(North)	100	
23	Extruder 1 to 4 (South)	100	234 - 238 Volts
24	Extruder 1 to 4 (North)	100	
25	SILO Area 5 & 6	50	Photo cell is used
26	SILO Area 1 to 4	50	Photo cell is used
27	Packing section	50	Only general shift

Sl. No.	Location details	Lux Level in Lumen Measured	Remarks
28	Packing section conveyor	100	Night shift-work
29	Packing supervisor table	200	
30	Finished product	50	
31	Rest Room	100	
32	S/S	200	Switched off
33	Utility Supervisor table	200	
34	Air Compressor Area	100	
35	Panel Area	100	Switched off
36	Sales Godown (E)	50	MLL in use
37	Sales Godown (W)	150	8 Nos. 250W HPMV change
38	I.R.Compressor (Old) R//A .	100	
39	Corridor (old)	80	
40	Rosins Dryer panel area	50	
41	Nara Dryer 1st/2nd floor	80	Photo cell used, Defeated & switched off
42	Wet Chips Conveyor	100	No work in night

APPENDIX - 9/3

LIGHTING LOAD MEASUREMENTS

PLANT : POY / R & D

DATE : 31.07.96

TIME : 14.30 hrs.

Sl.No	L.D.B.Details	pH	Measured					Remarks
			Volt	Amp	P.F	kVA	kW	
1	Lighting Panel	R	235	43.6	0.94	10.35	9.80	I_N = 30.8A
		Y	234	67.2	0.90	15.22	12.75	On GEB supply
		B	235	56.9	0.86	11.65	8.91	
2	R & D Section	R	244	5.1	0.94	2.33	2.20	I_N = 5.1A
	Lighting Panel	Y	244	2.6	0.91	0.73	0.97	Read on 1.8.96
		B	244	10.1	0.80	2.50	2.06	

APPENDIX - 9/4

ENERGY SAVINGS BY REPLACING MERCURY VAPOUR LAMPS BY HIGH PRESSURE SODIUM VAPOUR LAMP.

The plant has 11 nos. of 250W, HPMV lamps used for Sales Godown sections. Besides fluoroscent fixtures are also in use.

Basic data

No. of fittings	= 11 nos.
Total Wattage of fittings	= 250W x 11nos.
	= 2,750 W
Type of lamp	= HPMV

Derived Data

Energy consumption per year by above installation	= 2750 x 12 x300 kWh
	= 9900 kWh

Proposed

No. of fittings	= 11
Wattage per fittings	= 150
Type of lamps	= HPSV
Energy consumption per annum by proposed system:	= 11 x 150 x 12 x 300
	= 5,940 kWh
Energy savings	= 3,960kWh
Cost of savings	= Rs.16949 @Rs.4.28per unit
Cost of implementation (@ Rs.3000/- per fitting)	= 33,000/-
Simple payback period	= 1.9 years

APPENDIX 9/5

USE OF VOLTAGE CONTROLLERS

The total connected load (lighting) of POY plant = 85 kW

Considering 15% of energy can be saved by using voltage controller by setting voltage level at V_L = 380V, (V_{PH} = 219V).

Actual lighting load measurement gives following:

The present voltage level	= 235 Volts (GEB supply)
Actual Load (Measured)	= 31.46 kW
Energy savings based on above	= 4.7 kWh
Energy savings per day during day time	
a.Considering 60% loads switched ON for 10 hours	= 28.20kWh
b.Considering 80% loads switched ON for 14 hours	= 52.64 kWh
Total Energy savings per day	= 80.84 kWh
Annual energy savings(for 365 days)	= 29507 kWh
Cost of annual energy savings per annum	= Rs.1,26,290/-

Considering the load distribution, 1 no. of 100 kVA Voltage regulator can be installed at PCC outgoing feeder of lighting.

Cost of implementation (for automatic bypass Voltage controller)	= Rs. 2.00lakhs
Simple payback period	= 1.58 year (approx.)

APPENDIX -9/6

ENERGY SAVINGS BY SWITCHING OFF FLUROSCENT FIXTURE IN EXTRUDER & HPMV LAMPS AT WET CHIPS SECTION AREA, DURING NIGHT TIME (SWITCHING OFF TIME THROUGH TIMER)

		Extruder	Wet Chip Section
No. of Fixtures	=	27	8
Lighting Type	=	Fluroscent	HPMV
Wattage of Tube + Chokes or lamps	=	2 x 46W	250W
No. of fixures proposed for Switching off	=	35	6
No. of burning hours	=	12 hour	12 hour
Energy saving by switching off			
for 12 hours per day	=	35x92x12	6 x 250 x 2
	=	38640 kWh	18000 kWh
Cost of savings per year	=	Rs.1,65,379/-	Rs. 77,040/-
Total cost of savings per annum	=	Rs. 2,42,419/-	
Cost of implementation (timer contactor	=	Rs. 40,000/-	Rs. 20,000/-
& accessories @20,000 per panel)		for 2 panels	for 1 panel
Total cost of implementation	=	Rs. 60, 000/-	
Simple payback period	=	0.25 ≈	3 months

APPENDIX - 9/7

CASE - STUDY FOR REMOVAL OF SINGLE TUBE LIGHT FROM DOUBLE / TRIPLE FIXTURES

Proposal

Removal of single tube light from fixtures in non working areas such as carton storage, transformer room, corridors rest rooms etc.,

Present Status

Type of Lamp	= Fluorescent
Wattage	= 40 W
No. of tubes proposed for removal	= 65
Energy consumed at 24 h/d for 300 working days	= 65x40x24x300
	= 18,720 kWh
Cost of energy per annum	= Rs.80,122/-
Investment required	= Nil
Energy saving per annum	= Rs. 80,122/-
Simple payback period	= NIL

(Similarly other areas can be investigated for feasibility of removal of single tubelight to optimise savings)

APPENDIX - 10/1

POY EXTRUDER HEATER CAPACITIES

Sl No.	Equipment	No. of Heaters	Rated kW	Actual kW	Remarks
1	Extruder No.1	-	63.2	-	-
2	Extruder No.2	-	63.2	12.00	100/36 denier
3	Extruder No.3	-	63.2	26.4	100/36 denier (4.8 TPD)
4	Extruder No.4	-	75.1	39.0	125/36 denier (6 3 TPD)
5	Extruder No.5	-	55	12.9	100/36 denier (4 8 TPD)
6	Extruder No.6	-	55	-	-
7	Spin Block No.1	7 Nos.	65	-	Control heater
8	Spin Block No.2	7 Nos.	65	-	Control heater
9	Spin Block No.3	7 Nos.	65	-	Control heater
10	Spin Block No.4	7 Nos.	65	-	Control heater
11	Spin Block No.5	5 Nos.	89.0	-	16 metering pumps for 16 positions
12	Spin Block No.6	5 Nos.	75.0	-	8 metering pumps for 16 positions
13	Annealing Heater * No.1 to No. 4 No.5 Bottom No.6 Bottom	 - 16 Nos. 48 Nos. 16 Nos. 48 Nos.	 - 51.2 14.4 35.2 16.8	 - - - - -	 No - for Micro dimer - for Micro dimer

APPENDIX - 10/2

SURFACE HEAT LOSSES FROM SPIN BLOCK

Spin Block No.5

Section = Extruder

Application = To maintain POY temperature

Set Temperature = 289°C

Heat input

Phase	Amps	Volts	PF	kW
R	40.4	237	0.51	7.0
Y	40.2	237	0.55	7.2
B	40.35	237	0.51	7.0

Total power input : 21.2 kW

Heat output : 18232 kcal

Surface Heat Losses

Sl No	Particulars	Area, m^2	Temp, ^0C	Rad. loss, kcal/h	Conv. loss, kcal/h	Total loss, kcal/h
1.	Top face	12.28	110	5392.0	6266.9	11658.9

Total surface heat losses

Useful heat = Total power input - surface heat losses

= 18232 - 11658.9

= 6573.1 kcal

Appendix - 10/2 contd..

Sl No.	Particulars	k.cal/hr	%
1.	Heat input	18232	100
2.	Heat output a. Surface heat loss b. Useful heat	 11658.9 6573.1	 63.9 36.1

Surface Heat Losses from Spin Block

Spin Block No.6

Section = Extruder

Application = To maintain POY temperature

Set Temperature = 260°C

Heat input

Phase	Amps	Volts	PF	kW
R	53.1	238	0.78	9.4
Y	53.1	237	0.78	9.25
B	53.0	238	0.77	9.30

Total power input : 27.95 kW

Heat output : 24037 kcal

Surface Heat Losses

Sl No	Particulars	Area m^2	Temp, ^{0}C.	Rad. loss, kcal/h	Conv. loss, kcal/h	Total loss, kcal/h
1.	Top face	9.78	72	1840.4	2165.9	4006.4

Appendix - 10/2 contd..

Total surface heat losses

Useful heat = Total power input - surface heat loss

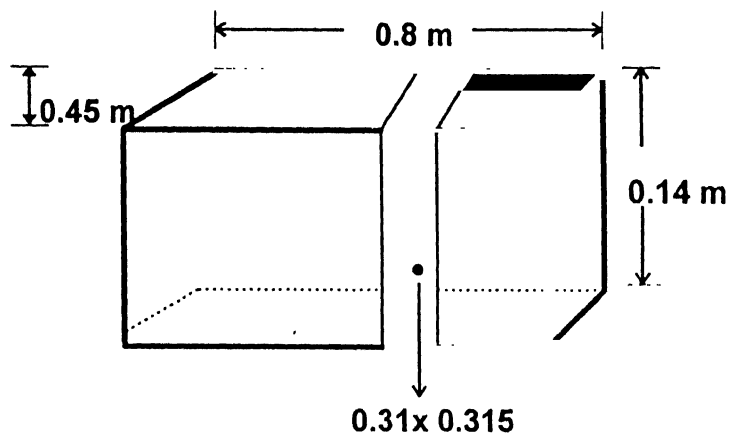
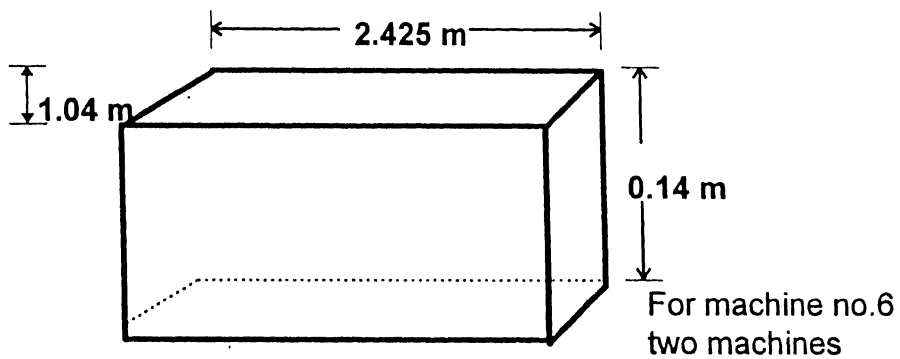
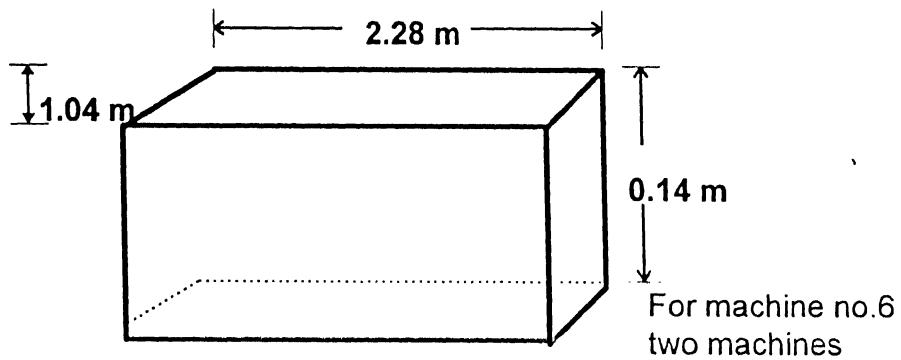
= 24037 - 4006.4

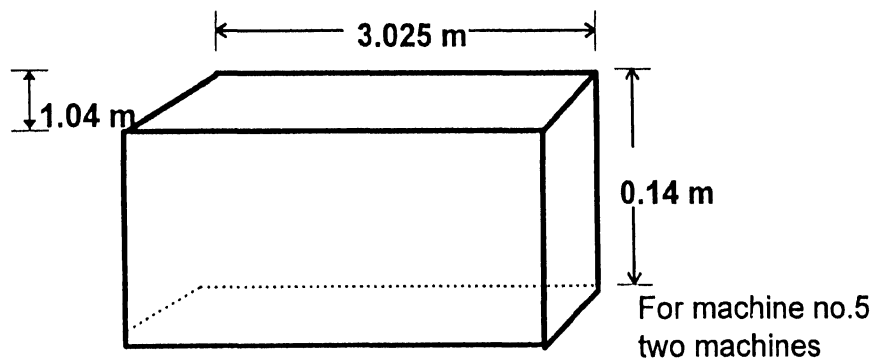
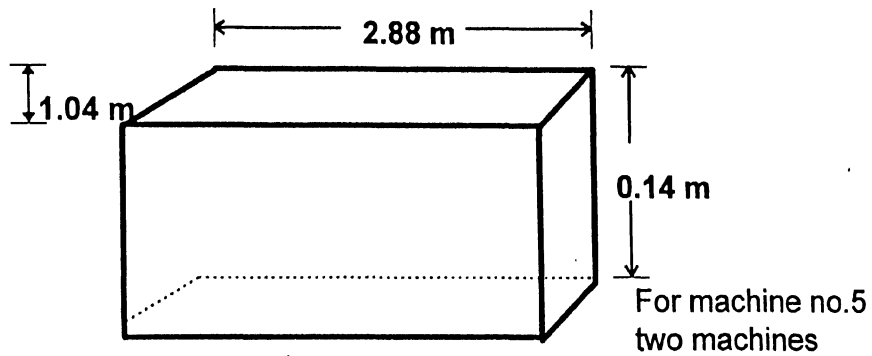
= 20030.6 kcal

Sl No.	Particulars	k.cal/hr	%
1.	Heat input	24037	100
2.	Heat output		
	a. Surface heat loss	4006.4	16.6
	b. Useful heat	20030.6	83.4

APPENDIX - 10/3

DIMENSIONS OF SPIN BLOCKS

For Surface Heat Loss Calculations

Spin block assembly # 6

Appendix - 10/3 contd..

Spin block assembly # 5

APPENDIX - 10/4

SURFACE HEAT LOSSES AFTER INSULATION

By providing Lloyd wool (IS - 3677-1985) of thermal conductivity 0.06 kcal/m-h-^{0}C density of 120 kg/m^3, surface temperature of each block is expected to be 44°C.

Surface heat losses after insulation

Spin Block Nos 5 & 6

Spin block no.	Particulars	Area m^2	Temp, ^{0}C	Rad. loss, kcal/h	Conv. loss, kcal/h	Total loss, kcal/h
No.5	Top face	12.28	44	605.42	603.82	1209.2
No.6	Top face	9.78	44	482.17	480.8	963.07

Heat loss savings in No.5 = 10449.7 kcal/h

Heat loss savings in No.6 = 3043.3 kcal/h

Power savings in No.5 = 12.15 kW

Power savings in No.6 = 3.5 kW

Each layer of 75mm thick Lloyd wool costs Rs.80/m^2, for spin blocks, two layers of Lloyd wool is required

Cost of Insulation for No.5 = 160 x 12.28 = 1964.8

No.6 = 160 x 9.78 = 1564.8

Rs. 3529.6

Power savings (80% of savings is achievable) = 15.65 kW

Savings in power (for 4000 hrs/of operation) = 15.65 x 0.80 x 4.28 x 4000

= 50,080 kWh x 4.28

= Rs.2,14,342 per year

Payback period = Immediate

APPENDIX - 10/5

SURFACE HEAT LOSSES FROM SPIN PACK OVEN

Spin Pack Oven No.1

Section = Spinning

Application = For preheating of spin pack

Set temperature = 340°C

Heat input

Phase	Amps	Volts	PF	kW
R	46.5	237	1.0	11.0
Y	47.0	237	1.0	11.0
B	46.7	237	1.0	11.0

Total power input = 33.2 kW

Heat output = 28552 kcal

Surface Heat Losses

Sl No.	Particulars	Area m^2	Temp. ^0C	Rad. loss, kcal/h	Conv. loss, kcal/h	Total loss, kcal/h
1.	Top side	3.655	74	729.1	860.3	1589.5
2.	Frount side	2.72	63	379.8	337.0	716.9
3.	Back Side	2.72	60	338.2	296.8	635.0
4.	left side	3.44	154	2887.3	2363.0	5250.4
5.	Right side	3.44	144	2534.3	2123.4	4657.8

Appendix - 10/5 contd..

Total surface heat losses

Useful heat = Total power input - surface heat losses

= 28552 - 12849.6

= 15702.4 kcal

Sl No.	Particulars	k.cal/hr	%
1.	Heat input	28552	100
2.	Heat output a. Surface heat loss b. Useful heat	 12849.6 15702.4	 45.0 55.0

Spin Pack Oven No.2

Section = Spinning

Application = For preheating of spin pack

Set Temperature = 340°C

Heat input

Phase	Amps	Volts	PF	kW
R	51.7	238	1.0	12.3
Y	51.6	238	1.0	12.2
B	51.6	238	1.0	12.2

Total power input : 36.7 kW

Heat output : 31562 kcal

Appendix - 10/5 contd..

Surface Heat Losses

Sl No.	Particulars	Area m^2	Temp. ^0C	Rad. loss, kcal/h	Conv. loss, kcal/h	Total loss, kcal/h
1.	Top side	3.65	62	491.6	564.9	1056.6
2.	Frount side	2.72	62	365.8	323.5	689.4
3.	Back Side	2.72	62	365.8	323.5	689.4
4.	left side	3.44	130	2081.0	1797.0	3878.0
5.	Right side	3.44	136	2269.6	1935.5	4205.2

Total surface heat losses = 10518.6 kcal

Useful heat = Total power input - surface heat losses

= 31562 - 10518.6

= 21043.4 kcal

Sl No.	Particulars	k.cal/hr	%
1.	Heat input	31562	100
2.	Heat output		
	a. Surface heat loss	10518.6	33.3
	b. Useful heat	21043.4	66.7

Spin Pack Oven No.3

Section = Spinning

Application = For preheating of Spin Pack

Set temperature = 340°C

Appendix - 10/5 contd..

Heat input

Phase	Amps	Volts	PF	kW
R	68.6	239	1.0	7.0
Y	68.5	238	1.0	7.2
B	65.0	238	1.0	7.15

Total power input = 21.35 kW

Heat output = 18361 kcal

Surface Heat Losses

Sl No.	Particulars	Area m^2	Temp. ^0C	Rad. loss, kcal/h	Conv. loss, kcal/h	Total loss, kcal/h
1.	Top side	3.655	56	382.0	427.4	809.5
2.	Frount side	2.72	52	232.3	194.9	427.28
3.	Back Side	2.72	55	271.1	232.1	503.27
4.	left side	3.44	136	2269.6	1935.5	4205.2
5.	Right side	3.44	148	2672.5	2218.6	4891.2

Total surface heat losses = 10836.45 kcal

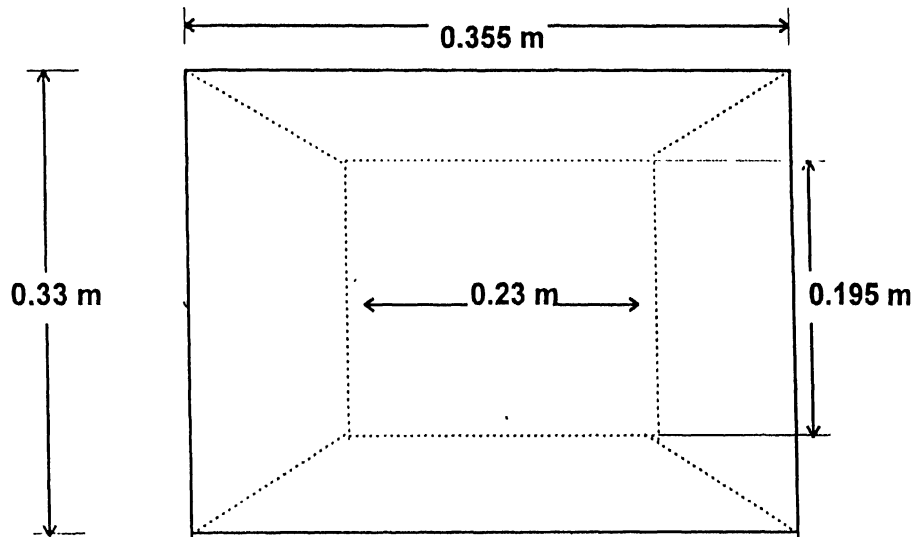
Useful heat = Total power input - surface heat

= 18361 - 10836.45

= 7524.5 kcal

Sl No.	Particulars	k.cal/h	%
1.	Heat input	18361	100
2.	Heat output a. Surface heat loss b. Useful heat	 10836 7524.5	 59.0 40.9

APPENDIX - 10/6

DIMENSIONS FOR SPIN PACK OVEN DOORS

Thickness of insulation required = 100 mm

Area of each door = 0.117 m^2

No. of doors on each face = 10

APPENDIX - 10/7

SURFACE HEAT LOSSES FROM SPIN PACK OVEN DOORS

Oven No.	Particulars	Area m^2	Temp. ^0C	Rad. loss, kcal/h	Conv. loss, kcal/h	Total loss, kcal/h
1.	Left side	1.17	154	982.0	803.7	1785.7
	Right side	1.17	144	861.9	722.2	1584.1
Total						3369.8
2.	Left side	1.17	130	707.7	611.1	1318.8
	Right side	1.17	136	771.8	658.3	1430.1
Total						2748.9
3.	Left side	1.17	136	771.8	658.3	1430.1
	Right side	1.17	148	907.9	754.6	1662.5
Total						3092.6

Surface heat losses after insulation to doors

Sl No.	Particulars	Area m^2	Temp. ^0C	Rad. loss, kcal/h	Conv. loss, kcal/h	Total loss, kcal/h
1.	Oven No.1	2.34	53	210.9	178.21	389.11
2.	Oven No.2	2.34	53	210.9	178.21	389.11
3.	Oven No.3	2.34	53	210.9	178.21	389.11
Total		7.02				

Reduction in heat loss

Sl No.	Particulars	kcal/h	kW
1.	Oven No.1	2980	3.46
2.	Oven No.2	2359	2.74
3.	Oven No.3	2703	3.14

Total power savings = 9.34 kW
(80% of savings is achievable)

Savings in power = 7.47 kW
(for 6000 hours/y, @ Rs.4.28 per kWh)

= 7.47 x 6000 x 4.28

= 44,820 kWh x 4.28

= Rs.191829/-

Appendix - 10/7 contd..

By providing Lloyd wool (IS 3677-1985) of thermal conductivity 0.06 k.cal/m.h.°C density of 120 kg/m^3, surface temperature of doors will come down to 53°C

Each layer of 50 mm thick Lloyd wool costs Rs.60/m^2 for doors, two layers of Lloyd wool required

Cost of Insulation for 3 ovens	=	60 x 2 x 7.02
	=	Rs.842.4
Payback period	=	Immediate